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EFFECT OF OBLITERATION OF THE ENDOLYMPHATIC SAC AND DUCT IN THE MONKEY

J. R. LINDSAY, M.D.
CHICAGO

THE DISCOVERY by Hallpike and Cairns [1] that the clinical syndrome known as Ménière's disease is based on anatomicopathologic changes in the inner ear, the most striking of which is dilatation or hydrops of the endolymphatic system, has directed attention to the physiology of the secretion and maintenance of endolymph.

The anatomic structures within the endolymphatic system which on the basis of structure have been considered by early anatomists to be adapted for secretion and removal of endolymph are the stria vascularis in the cochlear duct and the endolymphatic duct and sac.

Guild [2] performed experiments in which he injected a mixture of potassium ferrocyanide and iron–ammonium citrate into the basal turn of the cochlear duct in guinea pigs and demonstrated the blue granules in the walls of the endolymphatic sac. He concluded that endolymph flows from the cochlear duct to the endolymphatic duct and sac.

Anson and Wilson [3] made reconstructions of the endolymphatic duct system from serial sections by the Born wax plate method, confirming the observations of former anatomists and demonstrating the complex arrangement of the walls of the duct.

The rugose walls of the second dilatation (sinus II) and the cuboidal epithelium and surrounding vascular connective tissue constituted an arrangement which in their opinion might function in the resorption of endolymph.

Portmann [4] sealed the endolymphatic duct in a fish (Leiobatis postinaca) in which the duct normally opens on the surface of the head and observed disturbances in equilibrium afterward.

From the Division of Otolaryngology of the University of Chicago.

1. Hallpike, C. S., and Cairns, H.: Observations on the Pathology of Ménière's Syndrome, J. Laryng. & Otol. **53**:625-654 (Oct.) 1938.

2. Guild, S. R.: Observations upon the Structure and Normal Contents of the Ductus and Saccus Endolymphaticus in the Guinea Pig (Cavia Cobaya), Am. J. Anat. **39**:1-56, 1927.

3. Anson, B. J., and Wilson, J. G.: Form and Structure of Endolymphatic and Associated Ducts in the Child, Anat. Rec. **65**:485-498 (July 25) 1936.

4. Portmann, G.: Recherches sur la physiologie du sac et du canal endolymphatiques: Valeur fonctionnelle de l'organe endolymphatique des Sélaciens, Compt. rend. Soc. de biol. **85**:1070-1072, 1921.

McNally [5] incised, cauterized and applied pressure to the endolymphatic sac in rabbits without causing any great change in labyrinthine reactions.

In the belief that increased intralabyrinthine pressure was responsible for the disturbances of function in Ménière's syndrome, similar to the occurrence of hydrops in serous labyrinthitis, Portmann [6] devised an operation in which the sac was incised for relief of pressure.

The later discovery by Hallpike and Cairns [1] of hydrops of the labyrinth in Ménière's disease confirmed the theory of increased endolymphatic pressure, although the actual increase is probably only intermittent. The histologic picture has failed, however, to demonstrate the pathogenesis.

Nothing could be demonstrated which would relate the hydrops to an inflammatory reaction since no connective tissue reaction had occurred in the perilymphatic spaces, the change being confined apparently to an alteration of the endolymph, either qualitative or quantitative or both.

Various hypotheses have been proposed to explain the hydrops. On the basis of the histologic appearance Hallpike and Cairns [1] have postulated an interference with resorption of endolymph due to decreased vascularity of the perisaccular connective tissue. The histologic appearance of the endolymphatic duct and sac in other reported cases has not been consistently abnormal, however, and in cases reported by me [7] it has been considered to be within the limits of normal.

Other hypotheses which have been advanced include increased secretion of endolymph due to vasodilatation, advanced by Atkinson,[8] and increased capillary permeability on the basis of a local allergic reaction of the intrinsic type suggested by Williams.[9]

Since the experimental evidence so far available relative to a resorptive function of the endolymphatic duct has been limited to that obtained by Guild,[2] a series of experiments were undertaken to determine the

5. McNally, W. J.: Experiments on the Saccus Endolymphaticus in the Rabbit, J. Laryng. & Otol. **41**:349-360 (June) 1926.

6. Portmann, G.: Vertigo: Surgical Treatment by Opening the Saccus Endolymphaticus, Arch. Otolaryng. **6**:309-319 (Oct.) 1927.

7. Lindsay, J. R.: Labyrinthine Dropsy and Ménière's Disease, Arch. Otolaryng. **35**:853-867 (June) 1942; Ménière's Disease: Histopathological Observations, ibid. **39**:313 (April) 1944.

8. Atkinson, M.: Observations on the Etiology and Treatment of Ménière's Syndrome, J. A. M. A. **116**:1753-1760 (April 19) 1941.

9. Williams, H. L.: Intrinsic Allergy as It Affects the Ear, Nose and Throat: The Intrinsic Allergy Syndrome, Ann. Otol., Rhin. & Laryng. **53**:397-443 (Sept.) 1944.

effect of various degrees of destruction of the sac and duct. The experiments were done on monkeys. After the operations the animals were observed for gross disturbances of equilibrium, and the ears were sectioned for histologic examination at varying periods up to three and one-half months.

Fig. 1 (monkey 1).—Horizontal section of the left ear; × 44. The section passed through the endolymphatic sac and part of the medial dilated portion of the duct (sinus II), the rugose nature of whose walls are evident. The area where bone was removed from the walls of the sac is now in the process of being filled in by new bone. There is no proof that the sac had been opened.

EXPERIMENTS

Four monkeys (Macacus rhesus) were used in the series, 3 of which weighed approximately 10 pounds (4.5 Kg.) and 1 about 15 pounds (7 Kg.). Anesthesia

was induced by intraperitoneal injection of pentobarbital sodium, supplemented by administration of ether if necessary.

The operative procedures used in the study of seven ears of the series were similar. In general the technic was as follows: An endaural incision was made

Fig. 2 (monkey 2).—Horizontal section of the left ear; × 14.5. The section passed through the ampulla of the posterior semicircular canal and shows small remnants of the medial dilated portion (sinus II) of the endolymphatic duct (SII). The duct and sac distal to this point were obliterated. The defect in the bone made by the burr (*O*) now contains newly formed bone and marrow.

at the junction of the posterior membranous and bony semicircular walls from the floor to the roof, then extended outward between the tragus and the helix and upward in front of the anterior border of the helix into the temporal muscle to provide a free exposure of the mastoid process.

Exenteration of the cells of the mastoid process was done, exposing the bony walls of the horizontal and posterior semicircular canals.

By means of an electrically driven fine burr, the bone was then removed between the posterior semicircular canal and the dura of the posterior fossa from a level estimated to be just below the upper limb down to a point well below

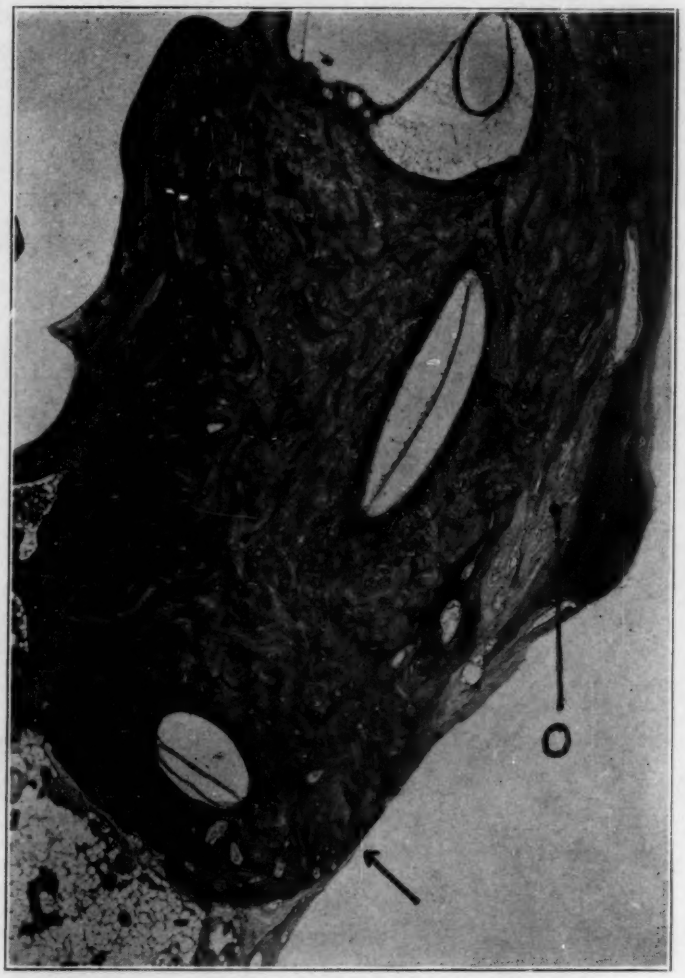

Fig. 3 (monkey 3).—Horizontal section of the right ear; × 19. The section passed through the endolymphatic duct at the junction of the proximal narrow and the medial dilated portion (sinus II). The latter has been destroyed along with the sac beyond it. The operative defect has been obliterated by displacement of dura against the bone of the posterior canal wall (arrow) and by new bone (*O*) extending up to the proximal narrow portion of the duct.

the lower limb of the canal. A small metal spatula was found helpful in guarding against injury of the sigmoid sinus. The bone was sometimes of sufficient width between the canal and the dural surface to permit introduction of the drill without

complete removal of the cortex, but the latter was always removed in the lower part in order to insure opening of the sac. By directing the tip of the burr anterolaterally after passing the outer border of the posterior canal it was hoped to destroy the medial dilatation (sinus II) of the aqueduct without encroaching on the small end of the horizontal or the lower limb of the posterior canal.

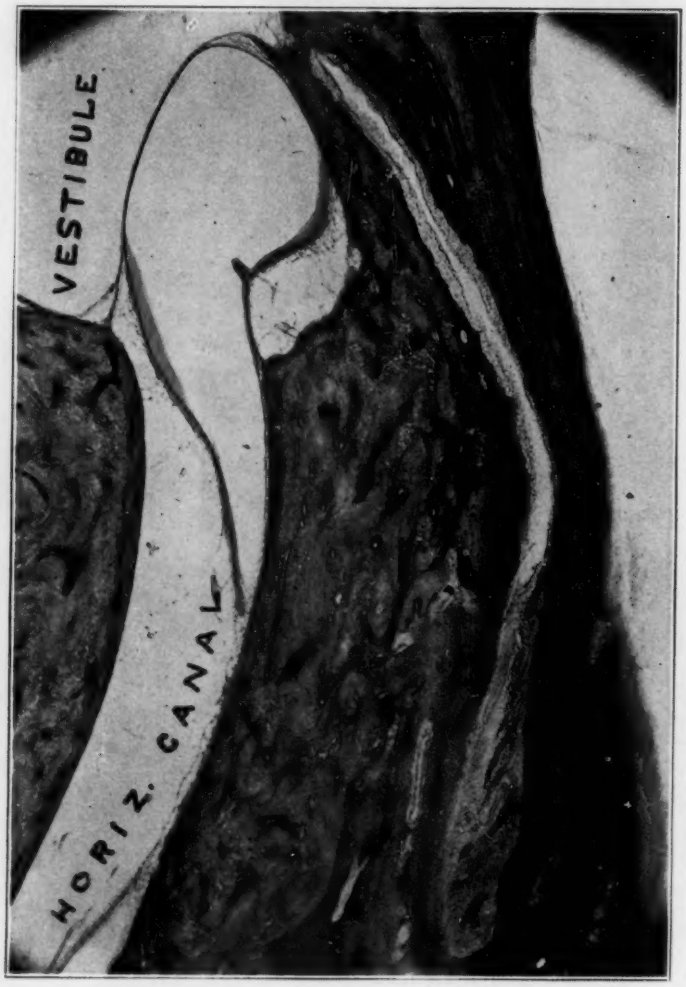

Fig. 4 (monkey 3).—Section of the right ear; × 40. The section has been taken at a slightly higher level than that in figure 3, to show the proximal narrow portion of the duct in which there is a small collection of amorphous material. The duct and sac beyond this narrow portion have been completely obliterated and the defect filled by new bone.

It was not always possible to determine with certainty whether fluid escaped from the sac at operation, but since complete obliteration was the objective, the histologic examination provided the more reliable evidence of the extent of the destruction.

The cavities were dusted with sulfathiazole powder and the skin sutured. The animals were killed by perfusion with isotonic solution of sodium chloride followed by solution of formaldehyde U. S. P. in 4 per cent dilution.

Monkey 1 (operated on May 17, 1945).—Both ears were operated on according to the method described in the foregoing paragraphs. No fluid was observed to escape from the region of the duct in either ear. On the following day and afterward there was no nystagmus or gross disturbance of the animal's equilibrium.

The animal was killed on July 20, 1945, two months after the operation.

Histologic Examination.—Right Ear: The middle ear was normal; there was much regeneration of bone in the mastoid cavity.

The drill passed between the posterior semicircular canal and the endolymphatic sac in this ear. Bone had been completely removed from the inner

Fig. 5 (monkey 3).—Horizontal section of the right ear taken through the cochlea, the saccule and the lower part of the utricle; × 16. The cochlear duct and the saccule show a normal contour. The hair cells are well preserved, and the spiral ganglion appears approximately normal.
The otolithic membrane is raised from the saccular macula (arrow)—probably a postmortem occurrence.

wall of the sac and duct in the region of sinus II; the area was now being filled in by new bone, but the duct and sac were still present. The extent of bone removal and irregularities in the sac indicated that the sac probably had been opened and injured, but proof was lacking.

The membranous labyrinth and the sense organs appeared histologically normal.

Left Ear: The drill had removed the bone from the wall of the sac and duct in the region of sinus II, and the defect was now filled by new bone (fig. 1). That the sac had been opened could not be proved. The membranous labyrinth and the sense organs appeared histologically normal.

Monkey 2 (operated on Nov. 27, 1944).—Both ears were operated on. On the left side clear fluid came from the region of the sac at operation. It was probably endolymph, but this could not be proved, since the tip of the burr was carried routinely beyond the field of vision in all operations.

On the right side bleeding occurred and landmarks were less definite. No fluid was observed to escape.

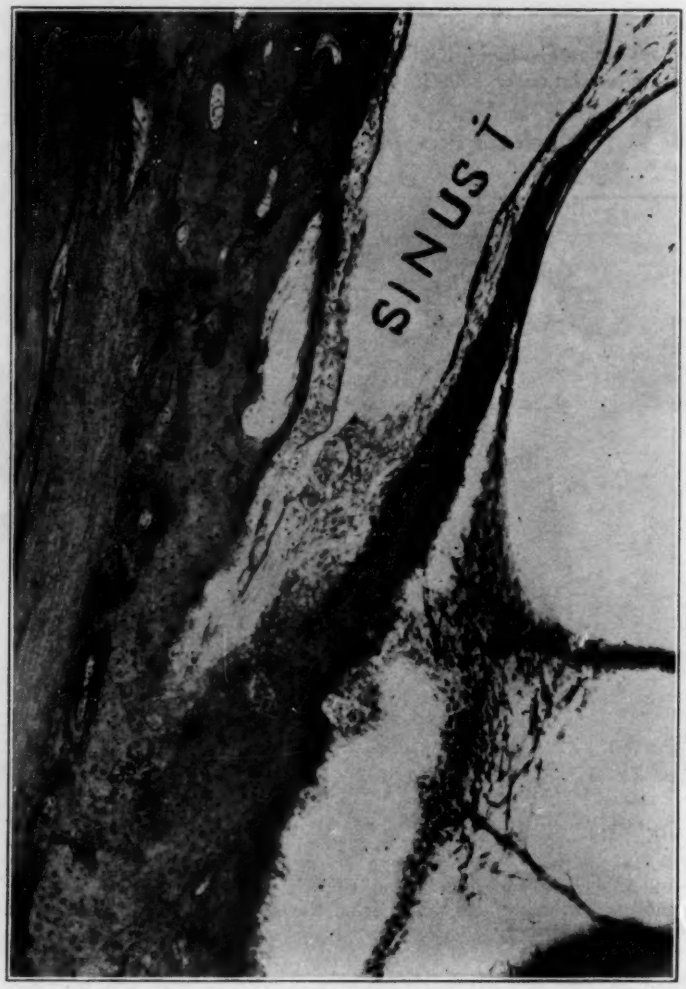

Fig. 6 (monkey 4).—Section of the right ear; × 100. It shows part of the proximal dilated portion (sinus I) of the endolymphatic duct and the beginning of the first narrow portion. The lining epithelium shows no abnormality.

Sulfathiazole powder was dusted lightly in both cavities and the skin sutured.

No spontaneous nystagmus was noted after the recovery from the anesthesia. There was no gross disturbance of equilibrium. The animal was killed by perfusion on Feb. 24, 1945, after approximately three months.

Histologic Examination.—Right Ear: The middle ear was normal. The mastoid cavity showed extensive regeneration of bone.

The drill had passed between the posterior canal and the duct and sac, removing the bony wall of the latter structures. Injury to the duct or the sac could not be demonstrated with certainty. The endolymphatic system and the sense organs appeared normal throughout.

Fig. 7 (monkey 4).—Section of the right ear; × 15. It was taken from slightly below that in figure 6 and shows new bone filling the area formerly occupied by the endolymphatic duct. The destruction of the duct extended into the proximal narrow portion almost to sinus I.

Left Ear: The middle ear was normal. The mastoid cavity showed extensive regeneration of bone.

The endolymphatic sac had been obliterated as well as the greater part of the dilated medial portion of the duct (sinus II). Remnants of the duct remained.

The defect made by the drill was filled by new bone and bone marrow, with dense fibrous tissue bordering on the remnants of the duct (fig. 2). The cochlear duct, the saccule, the utricle and the membranous canals appeared histologically normal, and the sense organs and neural elements showed no abnormality. The destruction of the sac and the major portion of the endolymphatic duct had produced no recognizable histologic change beyond the immediate site of injury.

Monkey 3 (operated on Dec. 1, 1944).—The same operative procedure was followed in the study of the left ear in this as in former animals.

As the area of the sac and duct were drilled out, no fluid was observed to escape.

A similar operative procedure was followed in the study of the right ear.

As the area of the duct was drilled out, a small amount of fluid escaped, which was probably endolymph.

Following operation there was nystagmus in the direction of gaze during the recovery from the anesthesia, but no nystagmus or deviation of the eyes and no gross disturbance of equilibrium was noticeable on following days.

The monkey was killed by perfusion on March 24, 1945, after approximately three and one half months.

Histologic Examination.—Left Ear: The middle ear was normal. The mastoid cavity showed extensive regeneration of bone with many marrow spaces but no evidence of pneumatization.

The endolymphatic sac had been completely obliterated, along with the dilated medial portion of the duct (sinus II). The narrow portion of the duct from the vestibular orifice down to the medial enlargement was present, and some amorphous material was recognizable in the lumen.

The posterior semicircular canal had been opened on its posteromedial surface and was filled by new bone at the point of injury.

The cochlear duct, the saccule, the utricle, the membranous labyrinth and the receptor apparatus appeared histologically normal. A small amount of amorphous material was present in the perilymphatic space around the utricle.

Right Ear: The middle ear was normal. There was extensive regeneration of bone in the mastoid cavity with many marrow spaces.

The endolymphatic sac and the dilated medial portion of the duct had been completely destroyed (fig. 3). The dura was found to be displaced in the region of the operative defect and lay against the bony wall of the posterior canal. No remains of the sac were found, while new bone filled the operative defect in the region of the destroyed dilated medial portion of the duct.

The proximal narrow portion of the duct (fig. 4) along with the proximal dilated portion at its origin, sinus I, was preserved and showed no definite deviation from the normal.

The cochlear duct, the saccule, the utricle and the membranous canals were of normal contour. The spiral ganglion and Corti's organ appeared normal. The otolithic membrane was raised from the saccular macula. The sensory epithelium appeared well preserved, however, and the separation of the otolithic membrane may have been a postmortem occurrence (fig. 5).

Monkey 4 (operated on Dec. 14, 1942).—Simple mastoidectomy was performed on the right ear. The horizontal and posterior semicircular canals were skeletonized, and the bone in the region of the endolymphatic sac and duct was destroyed with an electrically driven small burr. No fluid was observed to escape.

The animal was killed and perfused on March 25, 1943, approximately three and one-half months after operation.

Histologic Examination.—The middle ear was normal. The mastoid cavity was filled by callus in which osteogenesis was well advanced, and the antrum contained loose fibrous connective tissue. The channel which had been cut in the bone by the burr between the posterior canal and the dura of the posterior fossa was nearly filled with new bone, with some fat marrow in its central part.

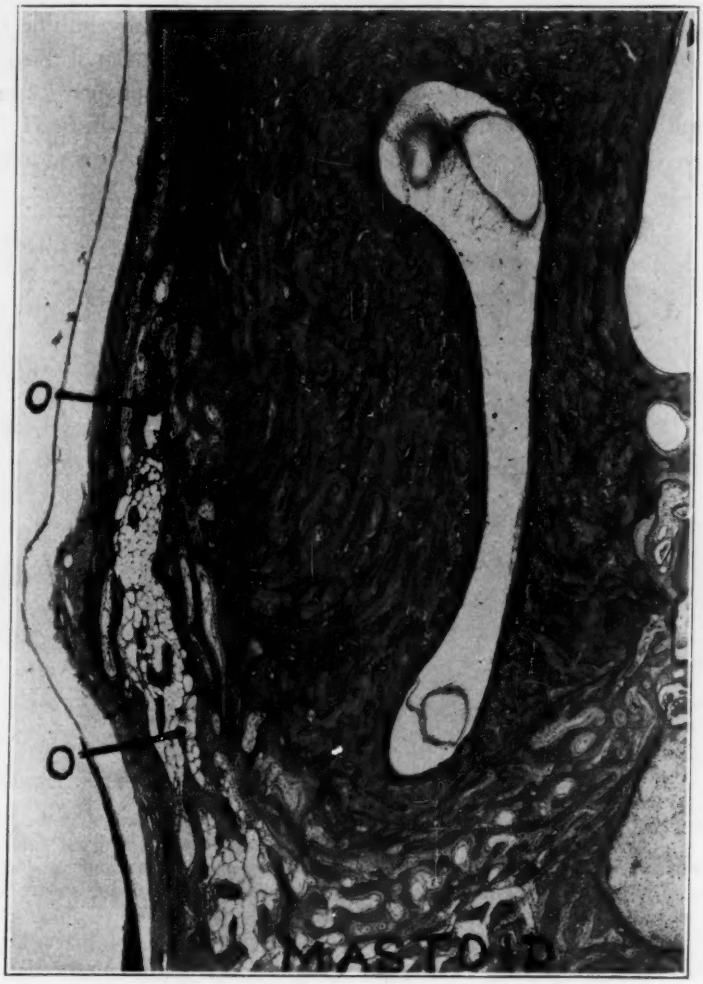

Fig. 8 (monkey 4).—Section of the right ear; × 20. At the level of the lower limb of the posterior canal, where the medial dilatation of the duct and the beginning of the sac are normally found, the operative defect is becoming obliterated by new bone (*O*).

The endolymphatic sac and the median dilated portion of the duct, sinus II, were completely absent, the area of destruction extending up almost to the proximal dilatation at the junction of the saccular and utricular ducts (figs. 6, 7 and 8).

The cochlear duct, the saccule, the utricle and the membranous canals had normal contour with the exception of a slight irregularity in Reissner's membrane

which was undoubtedly a postmortem occurrence. The stria vascularis, Corti's organ, the hair cells, the spiral ganglion and the vestibular sense organs appeared histologically normal (fig. 9).

SUMMARY OF RESULTS

In the 7 monkey ears in which it was attempted to destroy the endolymphatic sac and duct without damaging other labyrinthine structures the following results were accomplished: In 3 ears not more than exposure and possibly simple drainage had been accomplished. In 1 the sac and the major portion of the medial dilatation, sinus II, were destroyed. In 1 there was complete destruction of the sac and sinus II

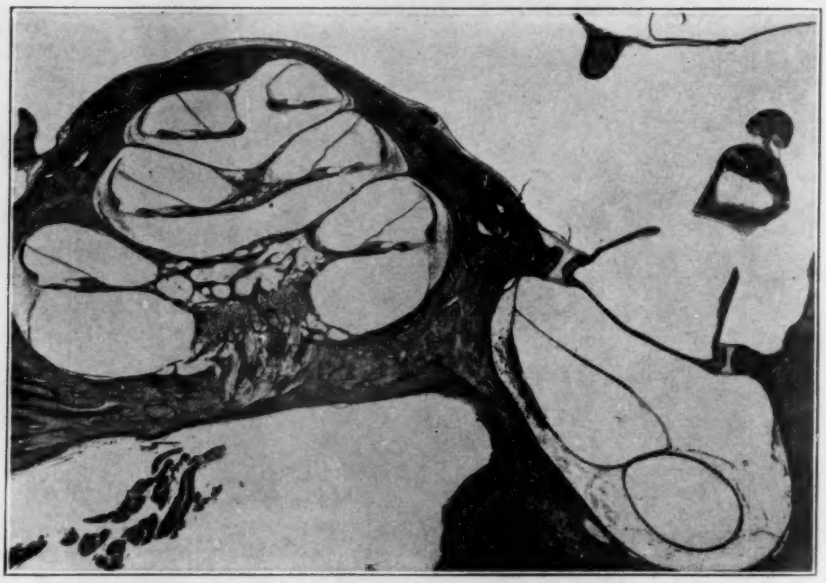

Fig. 9 (monkey 4).—Section of the right ear; × 24. It shows that the cochlear duct, the saccule and the utricle have a normal contour except for minor irregularities in Reissner's membrane which represent artefacts arising during the process of preparation. The stria vascularis, the organ of Corti, the spiral ganglion and the vestibular sense organs appear histologically normal.

plus accidental opening of the posterior semicircular canal. In 2 the sac and sinus II were completely destroyed without operative injury of other labyrinthine structures.

None of the animals was observed to have any gross disturbance of equilibrium on the day following operation or afterward. No nystagmus was observed after the animals were completely out from under the anesthetic.

Pressure exerted in the cavities over a temporary pack at operation in some of the ears produced no conjugate deviation of the eyes such as

occurs routinely when a fenestra is made in a semicircular canal without injuring the membranous canal.

The animals were killed from two months to three and one-half months after the operation and perfused.

The extent of the operative lesion was determined by histologic examination. No infections were found in the middle ear, the mastoid process or the labyrinth. Osteogenesis had progressed to varying degrees in the callus filling the operative defect. The membranous structures were well preserved. In all the ears the cochlear duct, the saccule, the utricle and the membranous canals showed no abnormality of contour that could not be explained as postmortem artefact, with the exception of 1 ear in which the posterior canal was injured at operation.

The sensory apparatus and neural elements appeared normal in all except the single ear in which the otolithic membrane was elevated from the saccular macula. The stria vascularis appeared normal in all ears as did also the cells of Hensen and Claudius.

COMMENT

These experiments demonstrate that in the monkey's ear the maintenance of a normal quantity of endolymph is not dependent on the existence of the endolymphatic sac or the more differentiated medial dilated portion of the duct. While the histologic structure of this part of the duct, consisting of cuboidal epithelium, rugose walls and surrounding vascular connective tissue has suggested a probable function, in the removal of endolymph, it now appears that this structure is not essential for performance of this function.

While the proximal dilatation at the junction of the utricular and saccular ducts (sinus I) along with a portion of the narrow part leading from it were not destroyed in these experiments, the lining in the proximal dilatation consists of an extension of the single layer of flattened cells lining the saccular and utricular ducts and assumes a cuboidal character only as the duct enters sinus II. The vascularity of the surrounding connective tissue becomes a feature only in the region of sinus II. It appears unlikely, therefore, that the portion of the duct which was not destroyed possesses any specialized function in the control of endolymph.

The fact that obliteration of the endolymphatic duct to this extent did not appreciably affect the volume of endolymph in the remainder of the system in periods of three and a half months rules out the hypothesis that hydrops of the labyrinth can be attributed to impairment of function of this structure.

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IMPROVED SURGICAL TECHNIC BASED ON MODIFICATIONS OF JANSEN-RITTER (LYNCH) AND CALDWELL-LUC PROCEDURES FOR CHRONIC SINUSITIS

WILLIAM LAWRENCE GATEWOOD, M.D.
NEW YORK

A STRIKING impression gained from a broad survey of present day literature pertaining to the management of chronic sinus disease indicates that efficacy is materially lessened by a lack of clearcut agreement and mutual understanding among many of those who are considered authoritative on this subject. While there can be no question as to the value of medical treatment as an adjunct to surgical in chronic disease of the sinuses, certain of the older practices, such as nasal suction, use of tampons and irrigation, can serve only as palliative measures. At the same time many who have become enthusiastic on the subject of nonsurgical treatment have clouded the issue by advocating pseudo-surgical practices, including physical and chemical therapy, that are of questionable value and claiming results that cannot be verified by clinical evidence.

This has been far from helpful to the somewhat isolated practitioners of medicine or surgery, who frequently have the opportunity to advise or treat such patients. A natural corollary is a disastrous confusion in the minds of many which fosters delay and a fatalistic acceptance of what they have come to regard as the inevitable.

The sole rationale of procedure is placed firmly on an essential scholarship in the medical sciences of anatomy, physiology and pathology. Too much emphasis cannot be placed on the great importance of studying anatomy thoroughly on the cadaver as a prerequisite to operating on the living subject. This experience is gained under proper supervision. A textbook knowledge of anatomy is important, but practical study of the subject in the anatomic laboratory is essential to a thorough understanding of surgical anatomy, so necessary at the operating table.

In much of the surgery practiced in the distant past, little consideration was given to the conservation of normal structures. If it is praiseworthy, in a discriminatory sense, to avoid operative interven-

From the Department of Surgery (Otorhinolaryngology), Medical Center, Jersey City, and the Department of Otorhinolaryngology, New York Polyclinic Medical School and Hospital.

tion whenever possible, it is admirable to exercise a full measure of acute perception in the selection of operative procedures which eliminate existent pathologic processes and yet conserve healthy tissues.

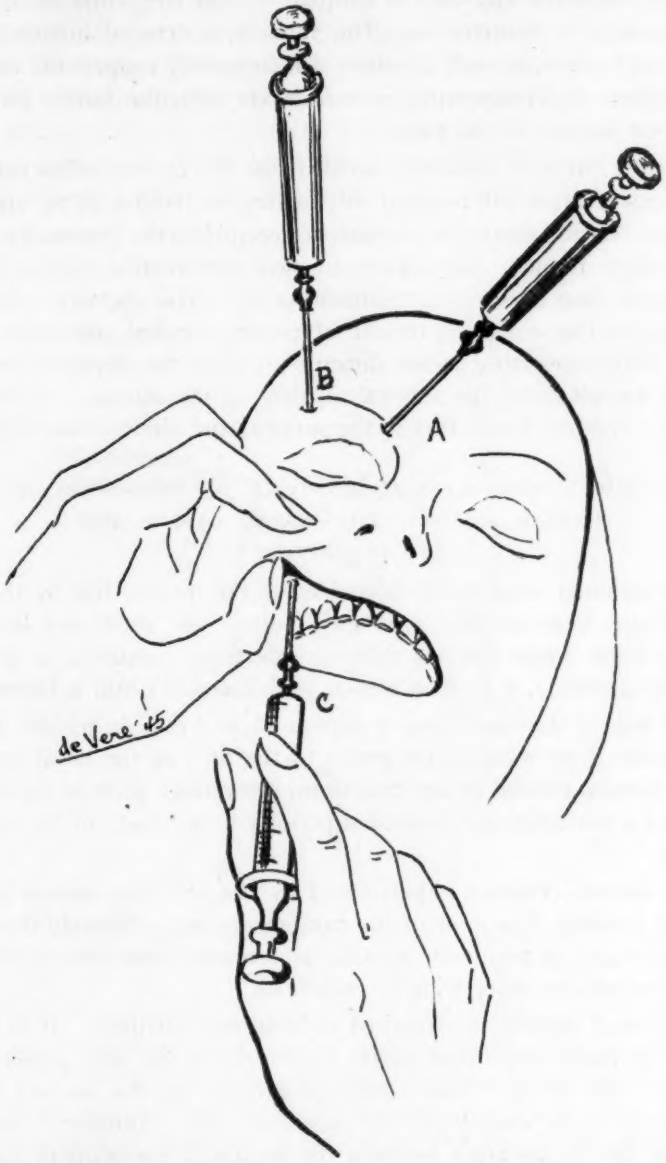

Fig. 1.—Injections for blocking the supraorbital, lacrimal and infraorbital nerves: *A*, supraorbital nerve. *B*, lacrimal nerve. *C*, infraorbital nerve.

A noteworthy fact about sinus disease is the similarity of the symptoms responsible for confusion in diagnosis and in the selection of the

type of treatment required. Many signs and symptoms remain obscure until careful clinical examinations are carried out and certain studies are made to arrive at the final correct diagnosis. It is obvious that no single diagnostic approach is adequate in that frequently all available methods must be resorted to. The value of a detailed history cannot be overemphasized, as such a history will frequently suggest the required examinations and cooperative investigations with the family physician in the best interest of the patient.

When it has been definitely decided that the chronic sinus condition under consideration will respond only to surgical treatment, the operative procedure selected should be adequate to accomplish the thorough removal of pathologic tissues. Incomplete surgical intervention in this field is often worse than no surgical treatment at all. The operative procedure necessary in the simplified technic of radical surgical treatment of the sinuses herein described is not difficult provided the operator possesses a sound knowledge of the surgical anatomy of the sinuses. Before outlining the technic, I will review the surgical and clinical anatomy.

SURGICAL AND CLINICAL ANATOMY OF THE ACCESSORY NASAL SINUSES, THE NASAL CAVITY AND THE SEPTUM

The common nasal cavity is divided in the median line by the nasal septum into more or less symmetric halves, the right and left nasal fossae. Each fossa has an anterior aperture (nostril), a posterior aperture (choana), a roof, a medial wall (septum) and a lateral wall.

The roof of the nasal fossa is narrow (1 to 3 mm. in width) and has an anterior slope which corresponds to the arch of the nasal bridge, a middle portion formed by the cribriform (sievelike) plate of the ethmoid bone and a posterior part formed superiorly by the body of the sphenoid bone.

The lamina cribrosa is perforated by the olfactory nerves and the ethmoid vessels. The floor of the nasal cavity runs obliquely downward and backward, is relatively smooth, is concave from side to side and is half an inch or more wide in each fossa.

The nasal septum is composed of bone and cartilage. It is formed mainly by three component parts: superiorly by the thin perpendicular lamina of the ethmoid bone; inferoposteriorly by the vomer; superoposteriorly by the rostrum of the sphenoid bone. Anteriorly the septal cartilage fills in the angle between the lamina of the ethmoid bone and the vomer.

Lateral Nasal Wall.—In a sagittal section of the head, the lateral wall of the nasal fossa presents an irregular surface due to the projection from it of the three scrolls of the conchae (turbinates), the superior,

the middle and the inferior concha. Separating these are the superior, middle and inferior meatuses.

The superior and middle conchae form the medial surface of the ethmoid capsule. The superior concha constitutes the medial wall of the ethmoid cells and overhangs the superior meatus confined to the posterior third of the lateral nasal wall. If the middle concha is dissected from its attachment it brings into view the entire area of the middle meatus, and the ethmoid bulla is seen as a large cell.

The superior and the middle meatus are of considerable clinical and surgical interest because the paranasal sinuses communicate with them

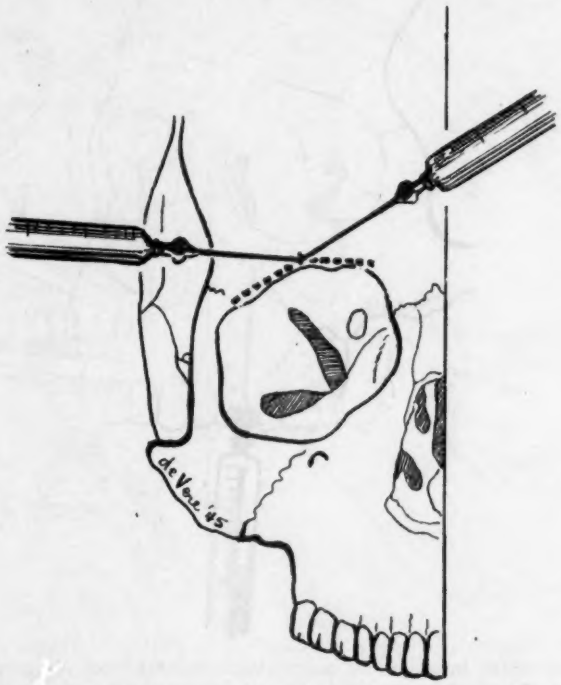

Fig. 2.—Alternate injection combining the supraorbital and lacrimal nerve blocks from one central puncture point.

by means of small ostiums. The frontal sinus, the anterior ethmoid cells and the maxillary sinus drain into the middle meatus, while the posterior ethmoid cells and the sphenoid sinus empty into the superior meatus and the superior nasopharyngeal recess (choana) respectively.

Other important structures of clinical interest lying within the middle meatus are the uncinate process, the hiatus semilunaris, the bulla ethmoidalis and the pars membranacea. The uncinate process is a long, flat, curved strip of bone extending downward and backward from the ethmoid capsule above and held in position by several projections articulating from adjacent bones.

The ethmoid bulla is situated immediately above the uncinate process. The hiatus semilunaris, a deepened slit or trough, lies between the uncinate process and the ethmoid bulla. It extends from the ostium of the anterior ethmoid cell or directly from the ostium of the frontal sinus to the infundibulum of the maxillary sinus. The ostium of the maxillary sinus lies in the deep recess of the maxillary infundibulum. The remaining orifices in the middle meatus, those of the pars membranacea, are closed by two layers of mucoperiosteum. This membrane is of surgical importance because it is the thinnest part of the lateral wall and after

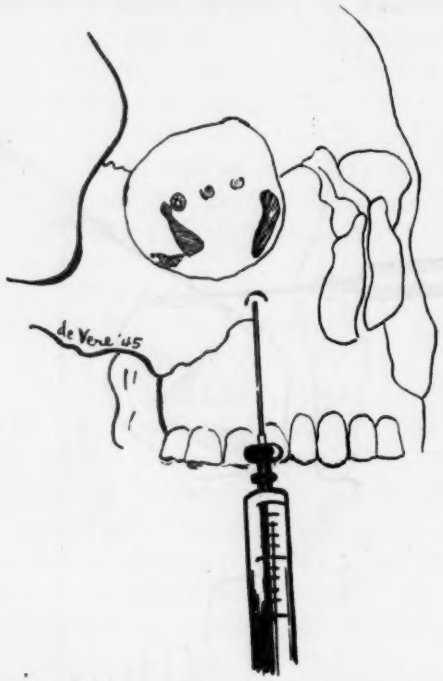

Fig. 3.—Intraoral injection for infraorbital nerve block. Note the osteologic relationship of the second bicuspid tooth and the infraorbital foramen.

puncture presents a surgical approach to the maxillary sinus if cannulation of the natural orifice for drainage is not feasible.

Frontal Sinus.—Embryologically, the frontal sinus is an offshoot from the ethmoid labyrinth. The development of the frontal sinus is subject to considerable variation after the age of 2 years and during puberty. In adults the sinus varies in size and shape, depending on the amount of reabsorption which the bone has undergone during its early development.

The frontal sinus lies in the ascending ramus of the frontal bone and is the most anteriorly placed of all the accessory sinuses of the nose. It possesses three walls, an anterior, a posterior and an inferior.

All are of great surgical importance. The anterior wall varies in thickness from 1/16 to 1/2 inch (1.5 to 12.5 mm.), the thickest portion being directly over the supraorbital ridge. The posterior wall is much thinner, seldom exceeding 1/16 inch, and forms part of the wall of the anterior cranial fossa. Surgically, dehiscences are to be considered, for when they occur, particularly in the posterior wall, the mucosa of the frontal sinus is in actual contact with the dura of the frontal lobe of the brain. When the defect is in the roof of the orbit, the periorbital tissues impinge

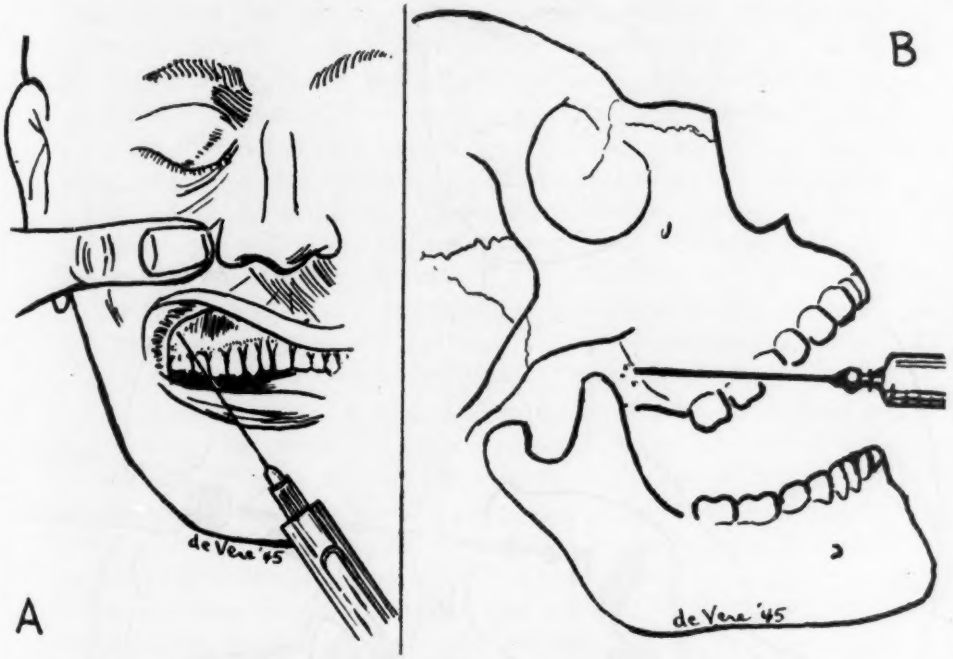

Fig. 4.—*A*, intraoral injection of the posterior superior alveolar (dental) nerve. The needle is inserted in the mucobuccal fold at the apex of the second molar tooth and is pushed upward, backward and inward for 2 cm.

B, same as *A*, showing the osteologic relationship of the molar teeth and the posterior dental nerve foramens on the posterior tuberosity of the maxilla.

directly on the mucous membrane of the frontal sinus. The inferior wall, or the floor of the sinus, is the thinnest and is in relation to the orbit, often extending far backward into the ethmoid labyrinth or over the orbital roof.

The interior of the sinus is usually not smooth but shows numerous partial septums and upward extending finger-like recesses, hiding large pockets. Diseased mucosa permitted to remain in these recesses will often cause recurrence after an external operation, an important point to be considered in the operative technic as illustrated in figure 14.

The ostium of the frontal sinus, or the communication between the frontal sinus and the middle meatus of the nasal fossa, lies at the postero-inferior portion of the floor of the sinus close to the posterior or cerebral wall.

The sinus drains into the middle meatus through the hiatus semilunaris in either of the following ways: (1) through an elongated canal,

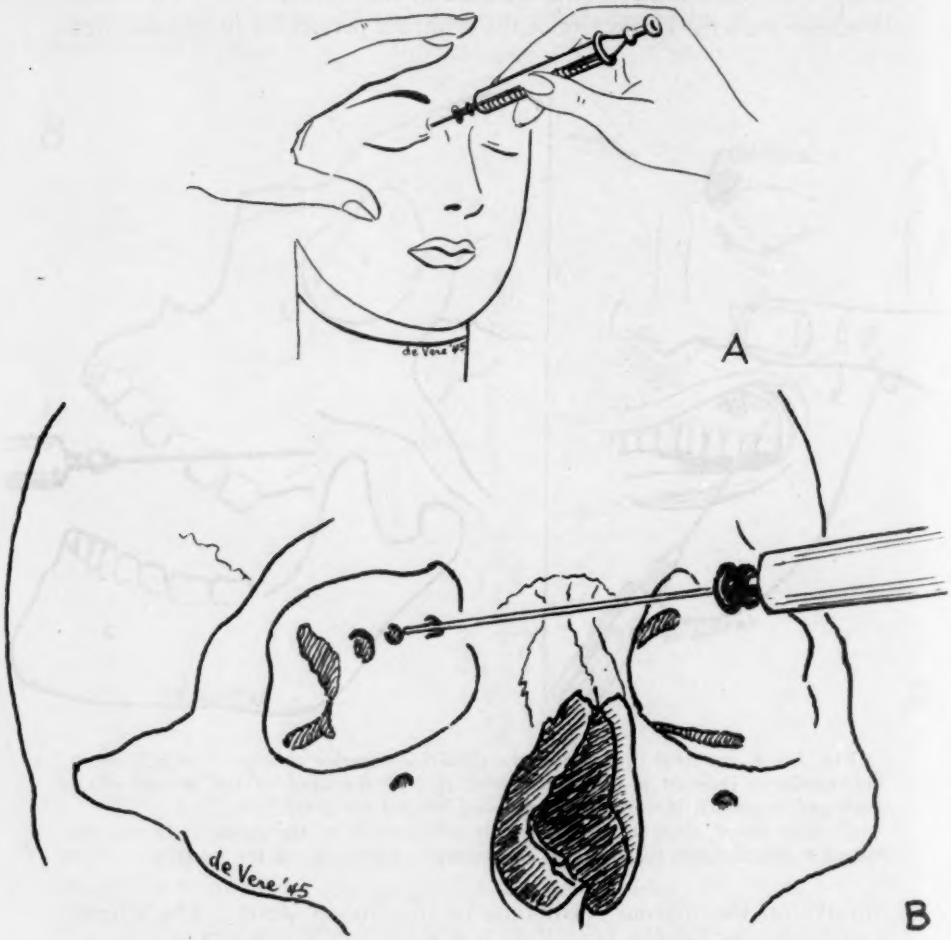

Fig. 5.—*A*, medial orbital injection to block the anterior and posterior ethmoid nerves and the supratrochlear and infratrochlear nerves.
B, same as *A*, showing the osteologic relationship between the foramens of the anterior and posterior ethmoid nerves and the foramen of the optic nerve.

the ethmoidofrontal duct, opening into the ethmoid infundibulum, or (2) simply through a foramen occurring directly in the roof of an anterior ethmoid cell. (3) It may drain anterior to the hiatus semilunaris, through a separate canal, entering the nasal fossa independently at the anterior

insertion of the middle concha. In this case the separate canal traverses the agger nasi region and is termed a nasofrontal duct. A true nasofrontal duct is rare.

Ethmoid Sinus.—The ethmoid cells, unlike the frontal sinus, are present at birth and develop early. At about 2 years of age an anterior ethmoid cell on each side begins to migrate upward into the frontal bone. By puberty it has grown half way over the orbit, with a proportional height.

For clinical purposes they may be grouped as anterior and posterior cells, draining respectively into the middle meatus and the superior meatus. The cells in each labyrinth vary in number, size and shape. In the normal subject the lowest number is two or three and the highest about ten or twelve. The ethmoid cells are situated anteroposteriorly along the entire superior margin of the nasal cavity lateral to the lateral nasal wall and medial to the lamina papyracea (the medial wall of the orbit) and the lacrimal bone. Therefore, an external approach through the thin upper wall of the lacrimal fossa is chosen as the most logical site to enter the ethmoid labyrinth.

Sphenoid Sinus.—Like the ethmoid and maxillary sinuses, the sphenoid cavity is present at birth, although it is but a small depression lying in front of the sphenoid bone. By 4 years of age the bone has enclosed it.

As in the case of the frontal and ethmoid sinuses, the sphenoid sinus is subject to considerable variation in size and shape. When it is well pneumatized, its walls are thin and in close relationship to the internal carotid artery, the optic nerve, and the hypophysis (pituitary gland). Dehiscences in its superior wall would place the mucous membrane of the cavity in direct apposition with the cranial dura.

Extension of disease of the sinus may readily involve cranial nerves traversing the cavernous sinus, for example, the abducens, the oculomotor and the trochlear nerves and the ophthalmic and maxillary divisions of the trigeminal nerve.

Maxillary Sinus.—Largest of the sinuses, the maxillary sinus (the antrum of Highmore) may be likened to a pyramid, the lateral nasal wall forming the base, the apex extending into the zygoma.

The superior wall, or the roof, lies under the orbit; the inferior wall, or the floor, crosses the alveolar process of the maxilla. In the Caucasian this floor is but a millimeter or two in thickness and the roots of the molar teeth may project as small mounds beneath the lining membrane of the sinus.

Anteriorly the boundaries of the sinus would be the maxillary canine fossa, and posteriorly the tuberosity of the maxilla. The size depends on the amount of reabsorption of bone which has occurred in early life. In man the capacity is about 16 cc.; in woman, about 10 cc.

Rhinologically, the most important wall is the nasal, because it is the thinnest and contains the sole opening into the sinus. The canine fossa wall is next in importance, as a radical surgical approach is made through this structure.

The ostium of the maxillary sinus lies behind the lower border of the uncinate process of the ethmoid bone, in the deepest part of a well. the maxillary infundibulum. At this point it enters the anterosuperior portion of the sinus. The ostium varies in size and may be round or oval. Accessory ostiums, when present, are found in the membranous part of the middle meatus, termed the pars membranacea.

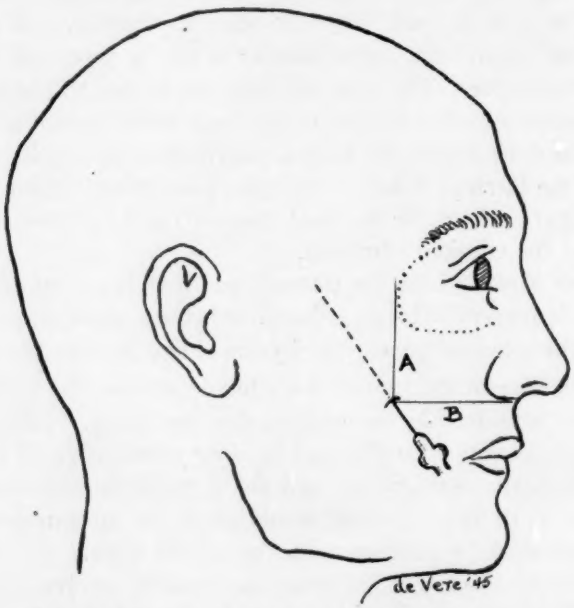

Fig. 6.—Extraoral injection for blocking the sphenopalatine ganglion and the maxillary division of the trigeminal nerve. The skin of the cheek is punctured with a needle, detached from the syringe, at a point where two lines intersect: line *A*, extending vertically from the lateral orbital rim; line *B*, extending laterally from the lower border of the alar cartilage of the nose. This is an alternate injection to supplant injections of the infraorbital and the anterior and posterior superior alveolar (dental) nerves.

The formation of partial septums and ridges in the sinus is of major surgical importance to the rhinologist, for these structures form pockets wherein residual remnants of diseased lining membrane will present foci for reinfection if not thoroughly removed during radical operation.

BLOOD SUPPLY OF THE NOSE AND THE ACCESSORY SINUSES

The sphenopalatine artery, a branch of the internal maxillary artery, enters the nasal fossa beneath the floor of the sphenoid sinus. The

anterior nasal branches cross and supply the middle and inferior conchae, and their respective meatal twigs enter the maxillary ostium to supply the lining membrane of the maxillary sinus. In addition, the sinus receives some smaller blood vessels at its posterior wall from the posterior superior alveolar artery.

Fig. 7.—Same as figure 6 (blocking of the sphenopalatine ganglion and the maxillary division of the trigeminal nerve by extraoral injection) showing the osteologic relationship between the ganglion and the nerve trunk to the posterior tuberosity of the maxilla.

Posterior nasal branches supply the posterior third of the lateral nasal wall. Transverse branches of the sphenopalatine artery cross the face of the splenoid sinus to gain the nasal septum. They supply the septum as they descend in the substance of its mucosa to reach the incisive foramen (anterior palatine foramen).

The anterior and posterior ethmoid arteries, which spring from the ophthalmic artery, enter the nasal cavity through the lamina cribrosa to supply branches to the anterior and superior parts of both the nasal septum and the lateral wall. The anterior ethmoid artery also gives twigs to the lining membrane of the anterior ethmoid cells while the posterior arterial branch supplies the membrane of the sphenoid sinus.

NERVE SUPPLY OF THE NOSE AND THE ACCESSORY SINUSES

The sphenopalatine ganglion, a branch of the maxillary division of the trigeminal nerve, lies suspended in the upper pterygopalatine fossa just below the inferior orbital fissure. From the ganglion, branches are given off which radiate in four directions, viz.:

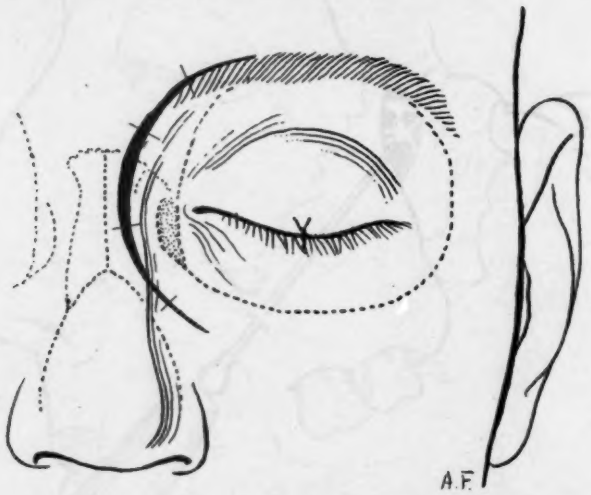

Fig. 8.—After the eyelid is closed with one suture to protect the cornea, a preliminary outline of the incision is traced superficially on the skin by a scratch mark with the scalpel. Transverse scalpel nicks or scratch marks are added to establish the exact coaptation of the edges of the wound at the close of the operation.

The incision extends along the upper border of the eyebrow, curves downward over the nasal bone close to the median line, over the dorsum of the nose to a point 10 mm. below the level of the lower border of the nasal bone. It is carried to the bone, including the periosteum.

Medial branches: Posterior superior nasal nerves to the mucous membrane of the nose, the nasal septum and the sphenoid sinus.

Descending branches: Anterior, middle and posterior palatine nerves to the mucous membrane and glands of the roof of the mouth, the soft palate and the tonsil.

Posterior branches: Nerve of the pterygoid canal and lateral posterior superior nasal nerves to the mucoperiosteum of the nose.

Anterior branches: Orbital filaments to the periosteum of the orbit.

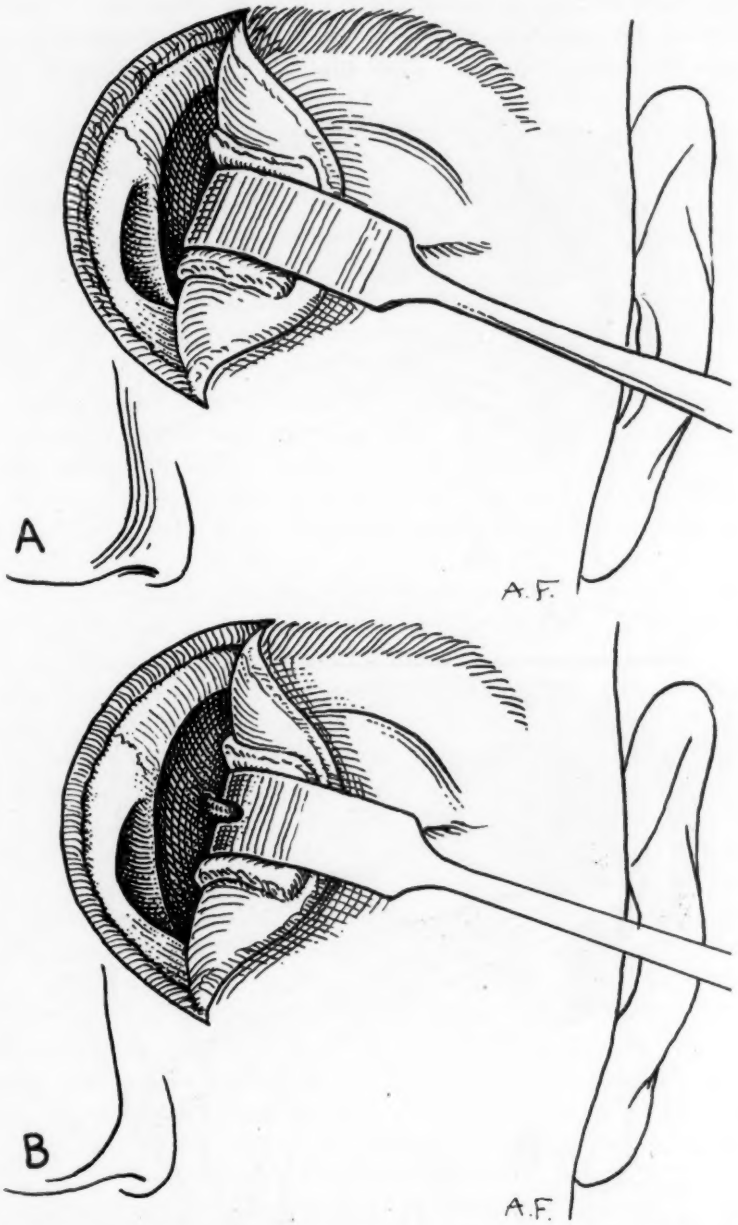

Fig. 9.—In *A* a flap has been created, with a bony shelf or shoulder which effectively serves as a bed to support soft tissues and subsequently as a means of establishing exact coaptation of wound edges; this obviates the more common result of sagging wound and disfiguring hollows and contractures. The soft tissues and periosteum are retracted laterally, protected by a gauze pad.

In *B* the anterior ethmoid vessels, with the nerve, are exposed and engaged in the slot of a special retractor (Ferris-Smith).

The anterior and posterior ethmoid nerves, from the ophthalmic division of the trigeminal nerve, also enter the roof of the nasal fossa through the lamina cribrosa. They supply the mucoperiosteum of the

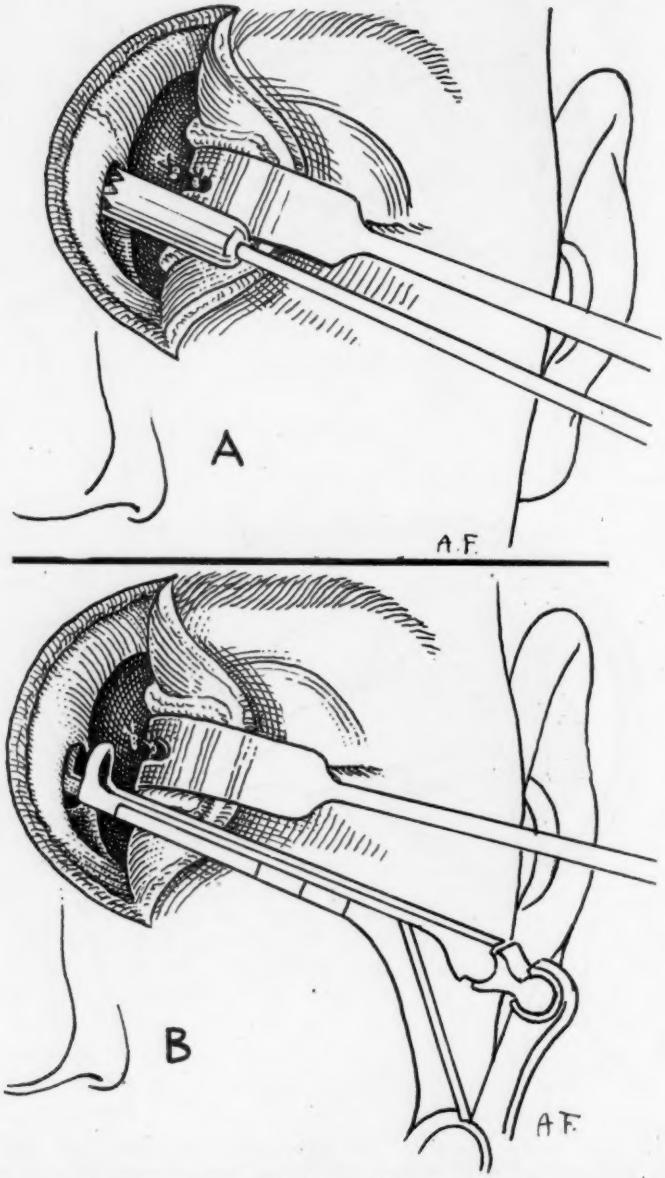

Fig. 10.—In *A* the anterior ethmoid vessels have been ligated. The lateral surface of the upper wall of the lacrimal fossa is being perforated with a ¼ inch trephine.

In *B* the beak of a biting forceps is introduced through the prepared orifice and with it the bone is bitten away upward and successively outward to the lateral limit of the floor of the frontal sinus.

anterosuperior part of the lateral nasal wall, the nasal septum, the anterior and posterior ethmoid cells and the sphenoid sinus.

ESSENTIALS OF TECHNICAL PRECISION

The essentials of technical precision in the radical surgical treatment of the sinuses are (1) safe and efficient anesthesia, (2) control of bleeding and (3) good exposure of the operative field.

Safe and Efficient Anesthesia.—The anesthesia may be local or general, depending on the age of the patient. Patients under 15 years of age do not, as a rule, do well under local anesthesia, as they often become tired and emotional before the operation is completed. These patients should have a general anesthetic, preferably by the endotracheal route, a Goudell-Waters balloon being employed. The purpose of the balloon is to prevent blood and other secretions from being aspirated into the lower respiratory tract. A further precaution to be observed in the avoidance of postoperative pulmonary complications is that of having the anesthetist do a careful tracheobronchial toilet after the removal of the endotracheal catheter.

Cyclopropane, being a drug that acts on the parasympathetic nerves, is contraindicated, as it precludes the use of epinephrine, which normally is required in the control of oozing.

Local anesthesia is the anesthesia of choice for adults, and it is produced by nerve blocks and surface applications. The supratrochlear, infratrochlear, supraorbital, lacrimal, anterior and posterior ethmoid, sphenopalatine, infraorbital, middle and posterior superior alveolar, and nasopalatine nerves are anesthetized with injections of a 2 per cent solution of procaine hydrochloride (novocaine) containing solution of epinephrine hydrochloride U. S. P.; 8 drops to the ounce (0.5 cc. to the cubic centimeter). Blocking these nerves as shown in figures 1 to 7 should produce anesthesia of all the sinuses. In addition, the following structures will require supplementary tamponage: the lining membrane of the maxillary sinus, the overlying membrane of the ethmoid capsule and the inferior meatus of the nose. These areas may be anesthetized by the topical use of cocaine and epinephrine. The maxillary sinus is filled with cotton or lint saturated with a 5 per cent solution of a cocaine salt, to which a few drops of solution of epinephrine hydrochloride U. S. P. has been added. This is accomplished during the course of operation through the opening in the anterior wall. Smaller pieces of cotton or lint, similarly treated with cocaine and epinephrine, are placed in the middle and inferior meatuses of the nose. The cotton or the lint in the nose is allowed to remain until contact is established as the operation progresses. The piece in the maxillary sinus should remain for five minutues before proceeding with the removal of the diseased contents of the sinus.

The technic of producing local anesthesia by nerve blocks and topical applications is delineated in figures 1 to 7.

Control of Bleeding.—For the control of bleeding, ligation of the ethmoid vessels is recommended. Bleeding from small capillaries or twigs may be controlled by the use of strips of cotton or lint dampened with solution of epinephrine hydrochloride U. S. P. and applied under moderate pressure. In the deeper structures, suction may be used as a supplementary measure in the production of a cleaner operative field. Usually after all diseased tissues have been removed, there is cessation of bleeding from most points.

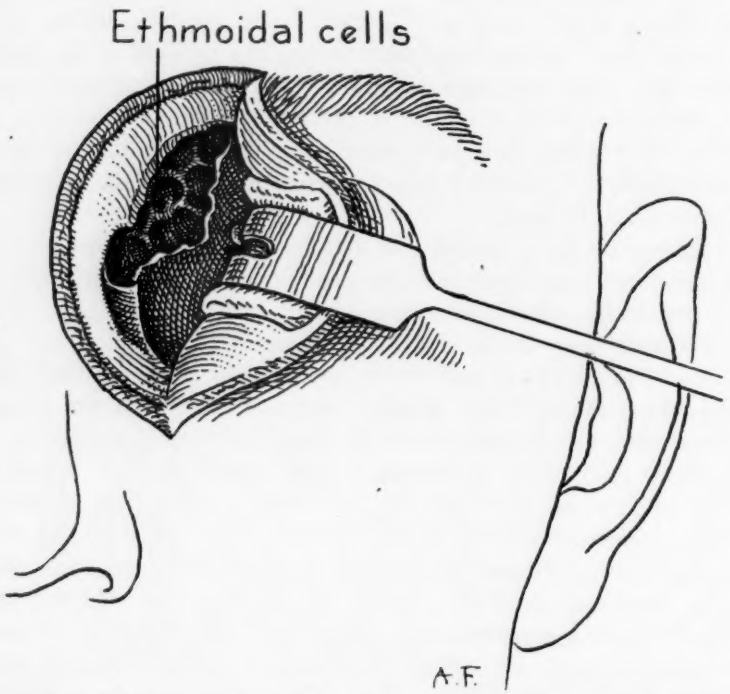

Fig. 11.—Partial removal of the anterior portion of the lamina papyracea (the medial wall of the orbit).

Good Exposure of the Operative Field.—This is accomplished by proper application of retraction plus the control of bleeding.

Presented with chronic pansinusitis and with evidence of marked degenerative changes and permanent thickening of the mucous membrane, one must realize that such changes are reversible only when radical surgical treatment is resorted to. The general condition of the patient being satisfactory, all the sinuses may be operated on at one time by following the technic about to be described. The consummation of the operative procedure should not require more than two hours.

With the patient whose general condition is less satisfactory it is best to do one side (frontal, ethmoid, sphenoid and maxillary sinuses), and during the patient's convalescence, probably two to three weeks, the other side may be operated on, depending on the condition of the patient. It is usually not necessary for the patient to remain in the hospital longer than one week if only one side is operated on. However, if both sides are corrected at one time, the hospital stay is usually lengthened two or three days.

NERVE BLOCKS FOR ANESTHESIA OF THE FRONTAL, ETHMOID AND SPHENOID REGIONS

Supraorbital Nerve.

Needle employed: 3 cm. long (25 gage).

Technic: Locate the supraorbital foramen on the margin of the orbital process of the frontal bone. The foramen or notch lies at the junction of the medial third with the lateral two thirds of the superior orbital ridge. Insert the needle into the skin, immediately over the supraorbital foramen (fig. 1 *A*), with the point of the needle directly in contact with the periosteum of the bone in this region.

Solution: 1 cc. of the anesthetic solution described on page 27 will give profound anesthesia in three or four minutes.

Structures anesthetized: Skin, subcutaneous tissue, periosteum and bone of the middle third of the eyebrow, the forehead, the upper eyelid and the anterior part of scalp.

Lacrimal Nerve.

Technic: Insert the needle into the skin directly over the superior orbital ridge at a point 2 cm. lateral to the supraorbital foramen (fig. 1 *B*). Direct the needle through soft tissue until it strikes the periosteum and bone of the orbital ridge, at an approximate depth of 5 mm.

Solution: 1 cc. of the solution described on page 27 is sufficient.

Structures anesthetized: Lateral third of the skin, subcutaneous tissue, periosteum and bone of the eyebrow, the forehead, the upper eyelid and the scalp.

Note: An optional injection (fig. 2) may be employed, accomplishing both the supraorbital and the lacrimal block from one central puncture point.

Infratrochlear Nerve.

The infratrochlear nerve escapes from the orbital cavity below the pulley of the superior oblique muscle, and anesthesia of this area is accomplished in the preliminary injection of the anterior ethmoid nerve. Therefore, independent injection into the infratrochlear nerve need not be considered. The supratrochlear nerve supplies tissues of the medial third of the eyebrow and the forehead, and this nerve is indirectly blocked with the supraorbital injection.

NERVE BLOCKS FOR ANESTHESIA OF THE INFRAORBITAL AND ALVEOLAR REGIONS OF THE MAXILLA

Infraorbital Nerve (Intraoral Approach).

Needle employed: 3 cm. long (25 gage).

Technic: The index finger of the left hand should rest directly over the infraorbital foramen, and the upper lip and the angle of the mouth should be

raised with the thumb to expose thoroughly the area which is to receive the needle (fig. 1 *C*). Puncture the mucobuccal fold above and lateral to the apex of the upper second bicuspid tooth (fig. 3). Slowly and carefully advance the needle vertically upward to the infraorbital foramen, a distance of approximately 2 cm. The ascending pathway of the needle should not follow the periosteum closely at any point until it strikes the area near the foramen. In other words, the needle bridges the depression of the canine fossa, an important phase of the technic to be considered (Gatewood [1]).

Solution: 2 cc. of the solution described on page 27.

Structures anesthetized: Skin and subcutaneous tissues of the lower eyelid; skin and cartilage on the lateral side of the nose; skin, subcutaneous tissue, periosteum and bone of the infraorbital region; skin, labial mucosa and gum of the upper lip.

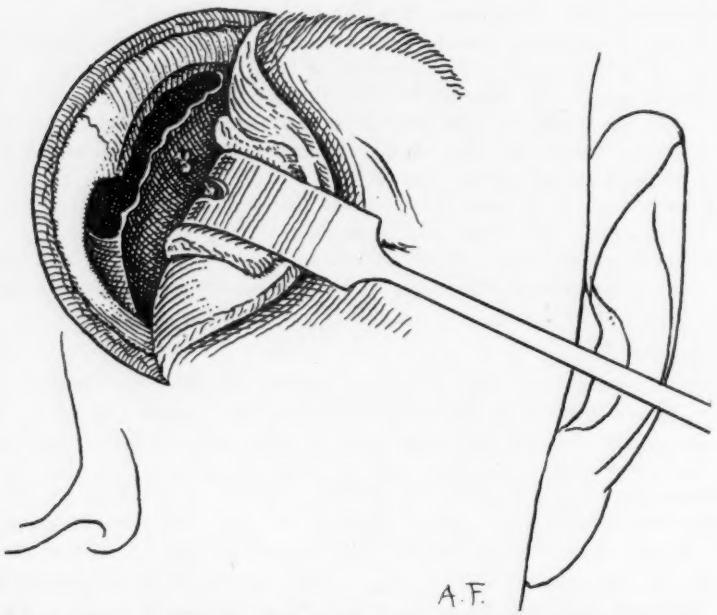

Fig. 12.—The anterior ethmoid cells have been entered and removed, with widening of the frontal infundibulum and the ostium frontalis and lateral extension of the floor of the frontal sinus.

Anterior Superior Alveolar (Dental) Nerve.

The branches from this nerve spring from the infraorbital nerve and traverse the cancellous trabeculae beneath the bony cortex of the maxillary–canine fossa wall. Therefore, they may be blocked during the infraorbital injection (de Vere [2]).

1. Gatewood, W. L.: Technique of Perineural Anesthesia for Radical Surgery of the Maxillary Sinus, Laryngoscope **28**:616 (Aug.) 1918.

2. de Vere, C. A.: The Pterygoid Venous Plexus and Its Relation to Block Anesthesia and Pathways of Infection, Dent. Items of Interest **65**:260 (March 1) 1943.

Posterior Superior Alveolar (Dental) Nerve.

Technic: Insert the needle in the mucobuccal fold at the apex of the root of the second molar tooth (fig. 4 *A*). Push the needle upward, backward and inward for 2 cm. Solution (2 cc.) is deposited, blocking these nerves as they enter minute foramens on the posterior wall of the maxillary sinus (fig. 4 *B*).

Structures anesthetized: Mucous membrane and gum of the upper molar region.

MEDIAL ORBITAL INJECTION BLOCKING THE ANTERIOR AND POSTERIOR ETHMOID NERVES

Anterior Ethmoid Nerve.

Needle employed: 4 cm. long (25 gage).

Technic: The puncture point is 1 cm. above the inner canthus of the eyelid (fig. 5 *A*). Push the needle through the skin, striking the medial orbital margin, and thence along the medial wall, in close contact with the periosteum, to a depth of 2 cm.

Solution: 1 cc. of the solution described on page 27.

Structures anesthetized: Mucous lining membrane of (1) the anterior ethmoid cells and the frontal sinus, (2) the anterior half of the middle and the inferior concha and meatus, (3) the anterior portion of the cribriform plate of the ethmoid bone, (4) the anterior and superior parts of the nasal septum.

Posterior Ethmoid Nerve.

Technic: Advance needle 1 cm. further, posteriorly, along the medial wall of the orbit.

Measurements: The average distance between the anterior and posterior ethmoid foramens is 1 cm. The distance from the medial orbital margin to the anterior ethmoid nerve is 2 cm.; therefore, the total distance over which the needle is inserted to block the posterior ethmoid nerve is 3 cm.

Solution: 1 cc. of the solution described on page 27.

Structures anesthetized: (1) Sphenoid sinus and posterior ethmoid cells and (2) posterior portion of the cribriform plate of the ethmoid bone.

Surgical notes: Great care should be exercised not to insert the needle too far posteriorly in view of the fact that the optic nerve is on a direct line with the needle. The average distance between the optic nerve, as it enters the orbit through the optic foramen, and the medial orbital margin is 4 cm. Therefore, it is important, in injection into the posterior ethmoid nerve, that the needle should not be inserted to a greater depth than 3 cm. (fig. 5 *B*). Even if the injection is made 0.5 to 0.75 cm. anterior to the posterior ethmoid foramen, the solution will reach the nerve by infiltration, producing the desired results.

EXTRAORAL INJECTION INTO THE SPHENOPALATINE GANGLION AND THE MAXILLARY DIVISION OF THE TRIGEMINAL NERVE

Needle employed: 5 cm. long (25 gage).

Technic: The syringe is to contain 2 cc. of the anesthetizing solution described on page 27. The needle, detached from the syringe, is inserted in the skin of the cheek at the point where the two lines shown in figure 6 intersect, line A extending vertically downward from the lateral orbital rim, line B extending laterally from the lower border of the alar cartilage of the nose.

Advance the needle upward, inward and slightly backward on the posterior tuberosity of the maxilla, to an approximate depth of 4 cm. (fig. 7).

Structures anesthetized: (1) Mucous membrane lining the posterior two thirds of the nasal fossa and septum, (2) mucous membrane of maxilla covering the upper gum and (3) mucous membrane lining of the maxillary sinus. This injection, if chosen optionally, supplants the injections into the infraorbital and the anterior and posterior superior alveolar (dental) nerves.

TECHNIC FOR OPERATION ON THE FRONTAL, ETHMOID AND SPHENOID SINUSES

1. The eyelid is closed with one suture to protect the cornea (fig. 8).

2. With the scalpel, and before injection for block anesthesia, an outline of the incision is traced superficially on the skin (fig. 8). Transverse scratch marks or scalpel nicks are placed at appropriate intervals to estimate what the exact approximation and coaptation of tissue edges will be when the wound is closed at completion of the operation. Small tampons of cotton or lint, saturated with solution of epinephrine hydrochloride U. S. P., will check cutaneous oozing.

3. The incision line extends along the upper border of the unshaven eyebrow, starting at its medial third and then curves downward over the nasal bone, arching close to the median line over the dorsum of the nose (fig. 8). It is continued downward and outward to a point about 10 mm. below the level of the lower border of the nasal bone (fig. 8).

4. The incision is carried to the bone, including the periosteum. A flap is thus created, and the wide medially curved incision provides a bony ledge, as a bed, to support tissue edges that form the suture line at the completion of the operation (fig. 9 *A*). In this step three important surgical improvements are achieved over incisions heretofore described:

(*a*) The soft tissue flap is provided with a substantial bony shelf or shoulder for its ultimate reposition.

(*b*) The line of tissue severance is kept out of the eyelid hollow beneath the supraorbital ridge.

(*c*) Union of tissue edges, at suturing, lies in an area medial to the cavity created by the necessary removal of bone—thus, by bridging it, improving the cosmetic effect.

5. Carefully retract soft tissues and periosteum laterally to expose the following structures (fig. 9 *A*):

(*a*) Inner third of the superior orbital ridge.

(*b*) Dimpled fossa for the pulley of the superior oblique muscle.

(*c*) Medial orbital wall (lamina papyracea of the ethmoid bone).

(*d*) Lacrimal fossa.

(*e*) Frontal process of the maxilla and its sutural junction with the nasal and frontal bones. Protect the orbital contents by placing a thin gauze pad between the blade of the retractor and the orbital tissues, arranging it in such a manner that vision within the orbital cavity is not obscured (fig. 9 *A*). More extended retraction, with a special slotted retractor (Ferris Smith), exposes the anterior ethmoid vessels (fig. 9 *B*).

6. Ligate the anterior ethmoid artery with its accompanying vein and then cut the vessels between the ligature and the medial orbital wall (fig. 10 *A*). This will

permit wider retraction of the orbital contents with good exposure of the operative field and reduction of subsequent bleeding when the anterior ethmoid cells are exenterated.

7. Attack the medial orbital wall by establishing, with a ¼ inch (6.5 mm.) circular trephine (fig. 10 *A*), an orifice in the thin wall of the lacrimal fossa. This obviates fractures and displacement of adjacent articulating bones, commonly caused by the application of a chisel to any of these bony parts.

8. Introduce into the prepared orifice the beak of a thin-nosed forceps (similar to Kerrison's), proceeding to bite upward and outward under the superior orbital ridge until the entire floor of the frontal sinus is removed (fig. 10 *B*).

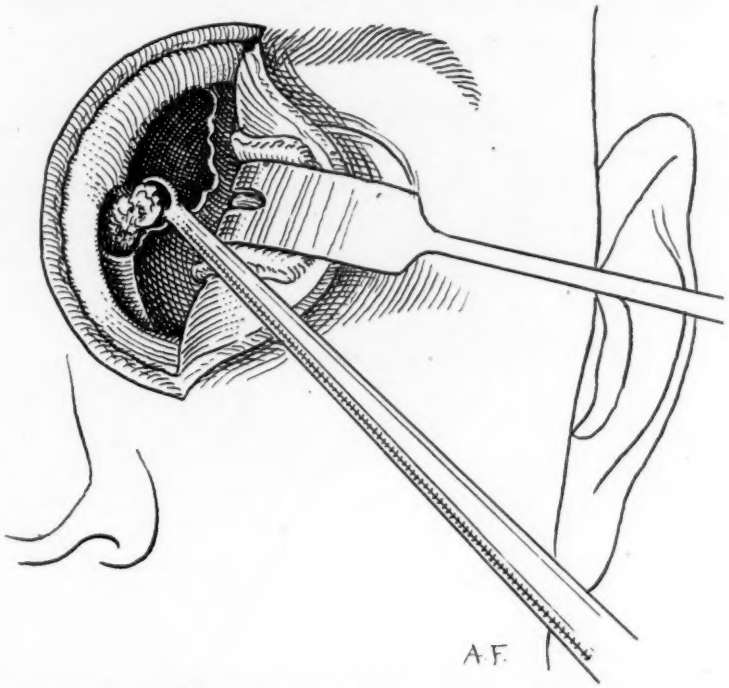

Fig. 13.—If agger cells are present, they are removed by curet, and at this stage the base of the ethmoid capsule and the bulla ethmoidalis are smoothly cleaned of septal remnants.

9. Bite down the lamina papyracea (os planum of the ethmoid bone) as far as the pathologic change indicates. If the resection of bone extends to the posterior ethmoid foramen, ligate the posterior ethmoid vessels (fig. 11) (Gatewood and Settel [3]).

10. Use biting forceps to remove the anterior and posterior ethmoid cells, the intracellular partitions and the lining membranes (fig. 12). If agger nasi cells are present, they are removed by curet (fig. 13).

11. With a small mastoid curet clean the frontoethmoid region to the extent that the ostium frontalis is widely enlarged (fig. 14). Remove all ridges or

3. Gatewood, W. L., and Settel, N.: Osteoma of Frontal Sinus with Invasion of the Orbit, Arch. Otolaryng. **22**:154 (Aug.) 1935.

partial septums as well as the lining membrane within the frontal sinus. Smooth all edges of the cavity with rongeurs. Clean the mucosa from the medial interseptal wall of the sinus and do not neglect to curet the pocket behind the maxillary process of the frontal bone (fig. 14).

12. If the sphenoid sinus has been invaded pathologically, remove its anterior bony wall with a ¼ inch trephine (fig. 15) or a sphenoid biting punch and gently remove with curet its lining membrane. Only the anterior bony wall of the sphenoid sinus is attacked, the nasal mucosa covering this wall being spared by preliminary incision and retraction to avoid severance and hemorrhage of traversing branches from the sphenopalatine vessels. The mucosa is incised transversely just below the sphenoid ostium, and the lower tissue flap is retracted downward with

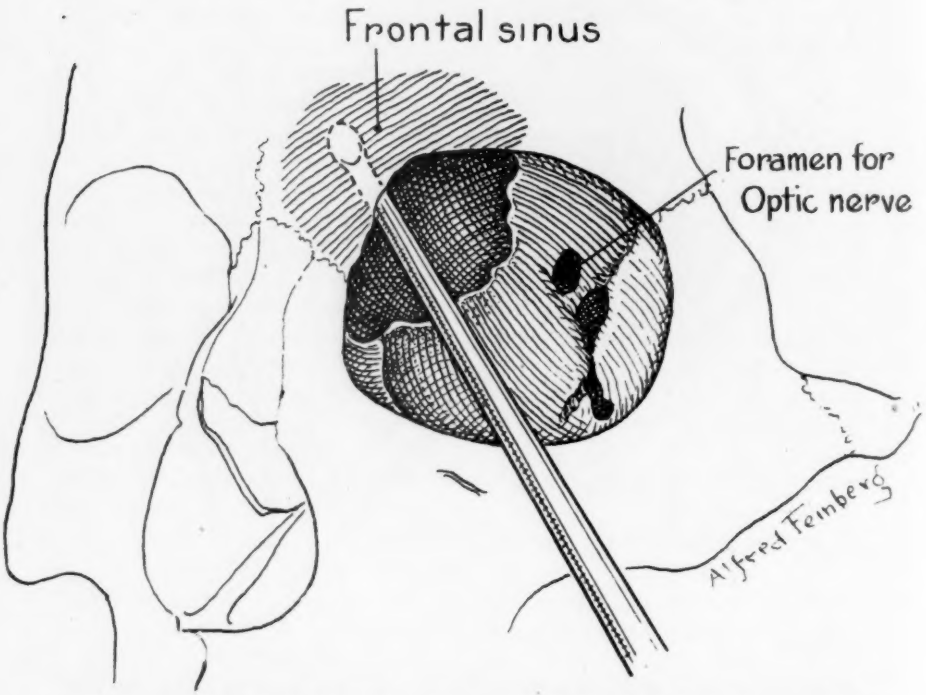

Fig. 14.—The ethmoidofrontal region with the ostium frontalis is widely enlarged. The roof of the frontal sinus with any pocket-like recesses and septums and the mucosal lining of the posterior aspect of the anterior wall and of the angular recess adjacent to the frontal septum are all removed.

a small periostotome, carrying the nasopalatine branches of the sphenopalatine vessels (fig. 15). Caution is taken, within the sinus, to curet only the floor and the medial intraseptal wall of the sinus. The roof and the lateral and posterior walls of the sinus are localities of danger. Their thin bony walls separate vital intracranial structures and the dura from the sinus cavity itself. In some subjects dehiscences in these bony walls permit the dura to rest in actual contact with the sphenoid lining membrane. Unless polypoid or cystic, the middle and inferior conchae (turbinates), with nasal mucosa intact, are left in situ (fig. 16 *A*). With no disturbance of these structures, nasal crusting is eliminated and postoperative observation is reduced.

13. Suturing: Suture periosteum and deep soft tissues with fine catgut no. 0000 and the skin with silk no. 0000 or finer, using interrupted approximation stitches.

14. Packing: A strip of 1 inch sterile bandage dampened with sterile water and thoroughly coated with sulfanilamide powder is placed in the sphenoid sinus and brought forward covering the anterior ethmoid area, with a loop being tucked upward into the frontal sinus. A bent grooved director is employed for this maneuver. The remaining end is draped downward in the anterior nasal fossa and brought outward through the vestibule (fig. 16 *B*). This packing is withdrawn on the fifth day, at which time some or all of the sutures are removed.

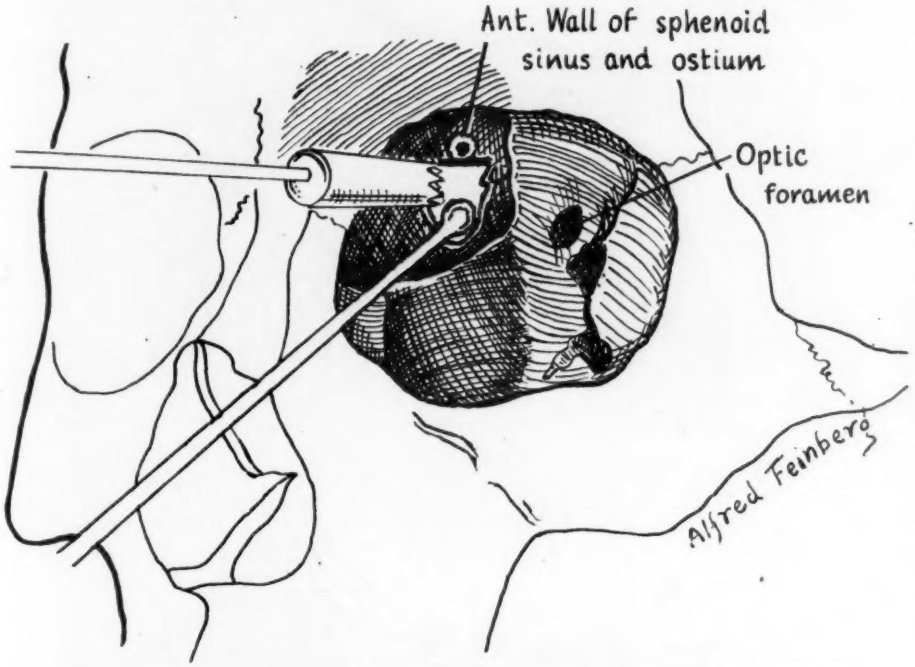

Fig. 15.—An incision is made immediately below the ostium of the sphenoid sinus. The mucoperiosteum of the anterior wall of the sinus, with vessels, is reflected downward by curet. A ¼ inch trephine is applied to the anterior bony wall of the sphenoid sinus.

TECHNIC FOR OPERATION ON THE MAXILLARY SINUS

15. The upper lip is displaced upward, and an incision of the nasolabial fold is commenced about ½ inch (12.5 mm.) from the frenum and is carried backward for a distance of 1½ inches (under 4 cm.) in the mucobuccal fold. The incision is carried to the bone, including the periosteum (fig. 17 *A*).

16. With a sharp periosteal elevator, the upper flap of soft tissue, including the periosteum, is elevated to the lower border of the infraorbital foramen. This exposes the canine fossa wall of the maxillary sinus. A ¼ inch trephine is applied to the thinnest portion of the canine fossa, and an orifice is created with a few turns of the instrument (fig. 17 *B*). Through this orifice is introduced the beak of a cutting forceps (similar to Kerrison's) with which the opening is enlarged sufficiently to permit inspection of the outline of the sinus cavity (fig. 17 *C*).

17. The lining membrane of the sinus is elevated with a malleable separator and extracted (fig. 17 *D*). If any portion or segments of the membrane should cling to the walls and remain adherent, they are freed and extracted with a forceps and a malleable suction apparatus tip (a eustachian catheter fills this requirement). Vigorous instrumental curettage of the sinus walls is contraindi-

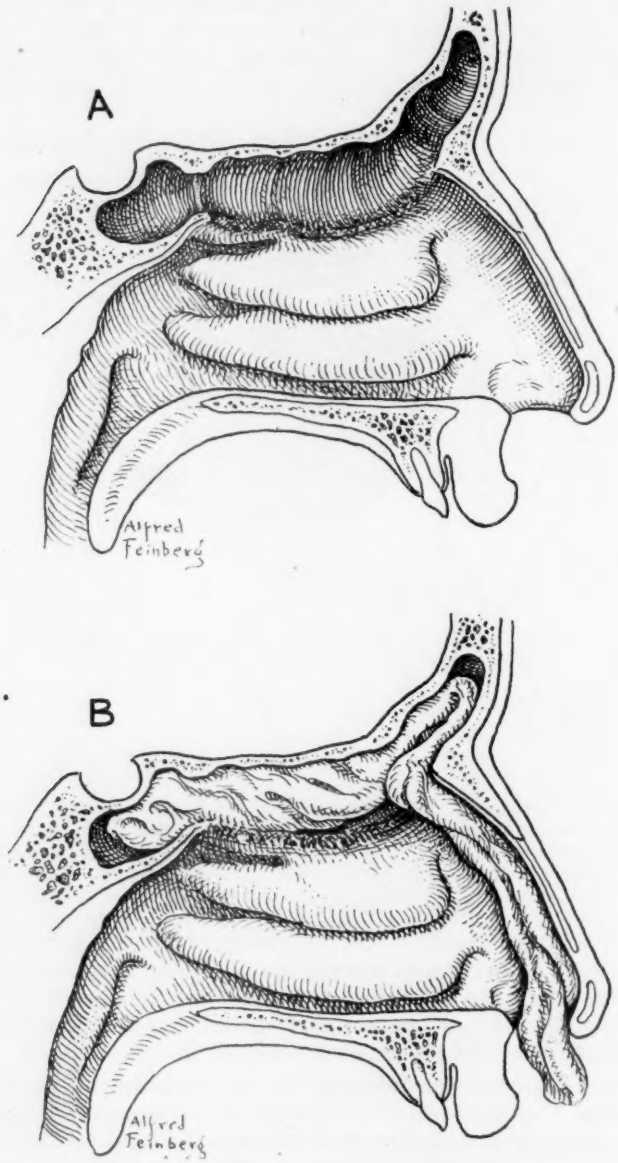

Fig. 16.—*A*, sagittal section showing the extent of the bone removal embracing the frontal, ethmoid and sphenoid regions. Note the preservation of the middle inferior conchae (turbinates) to maintain function of the nasal cavity.

B, placement of a gauze strip in the excavated sinuses.

cated, since it traumatizes the bone and may cause osteitis. The exceptional case (necrotic bone destruction of dental origin, which is encountered in about 5 per cent of infected antrums) will require resection of bone, particularly on the floor in the region of the tooth sockets.

Every shred of membrane and every fragment of diseased bone, together with partial septums, are removed.

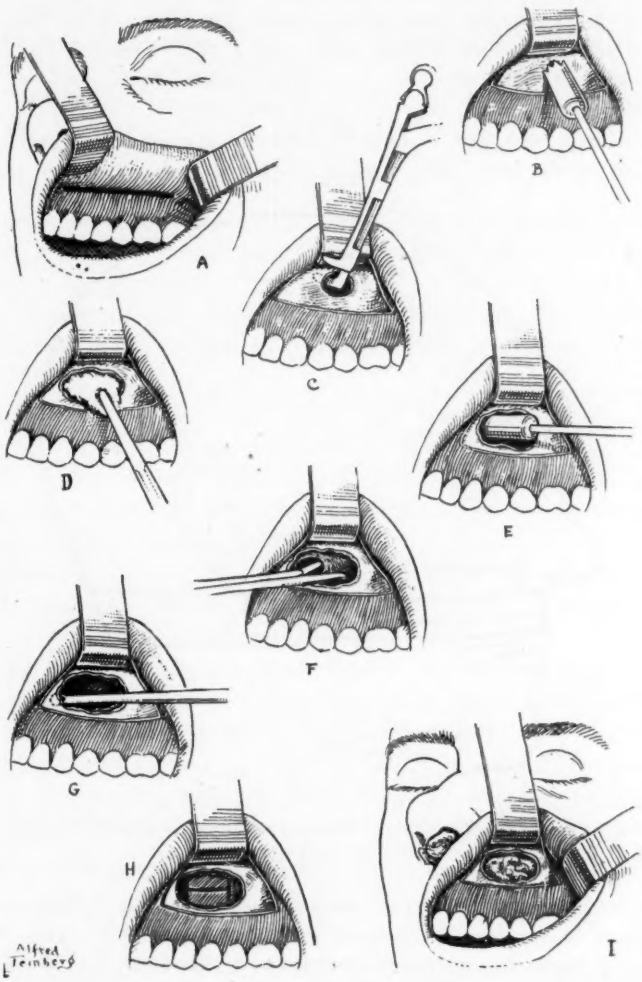

Fig. 17.—Sequence of surgical steps for the treatment of maxillary sinusitis. Note: In *B* the trephine should have been drawn to show the instrument at a right angle to the anterior maxillary wall, with all the trephine teeth in direct contact with the bony surface.

18. The next procedure concerns the nasoantral wall to establish a communication between the maxillary sinus and the inferior meatus of the nasal cavity. A ¼ inch trephine is applied against this wall at a point immediately above the floor of the nasal fossa and as far anteriorly as the opening in the anterior wall

will permit (fig. 17 *E*). With a few rotations of the trephine the thin lamina of bone is resected without perforating the overlying membrane of the nasal side. The movable blade of an alligator punch forceps is introduced between the bone and the nasal membrane and the opening enlarged by backward extension to create an orifice about ⅜ inch (about 1 cm.) in breadth and about 1 inch (2.5 cm.) in length occupying the central area of the inferior nasal meatus (fig. 17 *F*). With a medium-sized spoon mastoid curet the anterior angled wall of the sinus and the partition of the remaining anterior nasal wall are shaved down to a smooth continuity free of ridges or retentive sulci (fig. 17 *G*). This step of freeing the anterior angle of all diseased tissue is of utmost surgical significance, since neglect to clean this area thoroughly could provide a focal point for recurrence.

19. An incision, with a no. 11 Bard-Parker blade, is made in the nasal membrane from the maxillary sinus side, extending about 1 inch. At each end of the

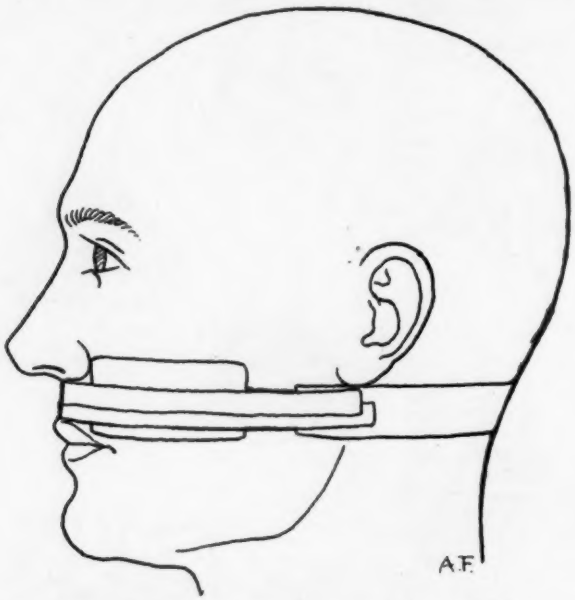

Fig. 18.—An external circular dressing over the maxillary sinus region, consisting of a gauze pad confined by adhesive strips.

incision a cross incision is carried upward and downward, the lower extension being slightly longer than the upward extension (fig. 17 *H*). This prepares a free-swinging lower flap of mucous membrane which folds over the floor ridge and extends to a degree into the sinus cavity. From this extension of membrane the cavity of the sinus is subsequently epithelized.

20. Packing: A strip of 1 inch sterile bandage dampened with sterile water and thoroughly coated with sulfanilamide powder is inserted in the maxillary sinus and brought through the nasomaxillary window to extrude slightly from the nasal vestibule (fig. 17 *I*). Thus two ends of gauze (one from the frontal and one from the maxillary sinus) are extending from the nostril, and as a means of identification either one of them is tabbed with a black thread tie.

21. External dressing: A strip of petrolatum gauze is placed over the line of incision in the frontonasal region and a pad of gauze coated with petrolatum is placed over the closed eye after the corneal protective suture in the skin of the eyelids has been removed. A final covering pad of fluffed gauze is applied and fixed with a roller bandage. An external circular dressing over the maxillary sinus region supplants the necessity for suturing the nasolabial and buccomucosal incision. This dressing consists of a gauze pad ½ inch in thickness compressed by the application of 1 inch adhesive strips which encircle the lower part of the face and the back of the neck. That portion of adhesive strip encircling the back of the neck is first coated with cotton to prevent adherence to the hair (fig. 18).

Postoperative observation is confined to three or four office visits, which are merely to allow one to follow the progress of healing. It is gratifying to note the absence of obstructive crusting.

SUMMARY

A technic is described which accomplishes the complete removal of pathologic tissue, the conservation of operative time and the reduction of trauma of healthy tissues to a minimum. The function of the nose is left undisturbed, and intranasal inspection at any subsequent time encounters no gross evidence that operative procedures have been undertaken.

With the patient who has a history of long-standing chronic sinus disease and whose sinuses contain thickened membrances with irreversible degenerative changes not responding to nonsurgical treatment, the only sound surgical procedure is the thorough removal of the membranes and any diseased bone that may exist.

Postoperative healing is obtained by the formation of a dense layer or fibrous connective tissue which becomes epithelized as the mucous membrane of the nose grows into the sinus cavities.

Diplopia is seldom encountered, and in the rare cases in which it occurs, is only transitory. As to the facial appearance, esthetically speaking, the incisional wound is not recognizable.

In subjects with extremely large frontal sinuses showing multilocular recesses and extending laterally to the zygomatic bone, an incision of greater extent will be required in the manner of the Killian procedure.

The illustrations embracing block anesthesia were prepared by Dr. C. A. deVere.

111 East Sixty-First Street.

RADIATION THERAPY FOR THE REMOVAL OF ADENOID TISSUE

DONALD F. PROCTOR, M.D.
BALTIMORE

IT IS NOW the carefully considered opinion of many otolaryngologists that infection of nasopharyngeal lymphoid tissue is a factor of the greatest importance in diseases of the respiratory tract and the ear. From the history alone it is apparent that in many patients recurrent infections of ear, nose and throat have their beginning in the nasopharynx. Careful nasopharyngeal examinations and the results observed after elimination of infected adenoids have consistently confirmed this observation. Although this has been especially emphasized in recent years, it has been well recognized for a long time, as demonstrated by the frequency with which repeated surgical attacks on the nasopharynx have been carried out on children with persistent respiratory or aural diseases.

Although radiation therapy for the elimination of adenoids has been used for over twenty years and many thousands of patients have been treated, few reports on the results obtained are in the literature.

During the past three years at the Hagerstown Clinic 400 patients have been so treated, and in most of them the results have been observed over long periods. The average period of observation for the total of 400 has been thirteen months to date (June 1946), and most of the more interesting cases have been followed for almost two years. A total of 1,110 radium treatments have been given to the 400 patients so far. There are 211 males and 189 females; 286 of the patients are between 5 and 15 years of age (fig. 1). As the treatment of many of these patients is not as yet complete, results must not be considered final, either for the bad or for the good.

These patients received, in addition to radiation therapy, surgical treatment of the tonsils or the adenoids when indicated (mastoidectomy or nasal operation in some instances) and local treatments to the sinuses, the nose or the ears.

RESULTS

The results are best considered under two headings: (1) changes in the nasopharyngeal lymphoid tissue and (2) changes in the patient's symptoms.

Changes in the Nasopharyngeal Lymphoid Tissue.—When first seen at the clinic, not a single one of these patients was totally free of nasopharyngeal lymphoid tissue (25 showed only minute traces of such tissue) (fig. 2). At the latest examination, 99 patients had no lymphoid tissue in the nasopharynx, and in an additional 167 patients only minute traces remained. At the first examination 127 patients had a large mass of adenoid tissue, and 7 patients still had a large mass when last seen.

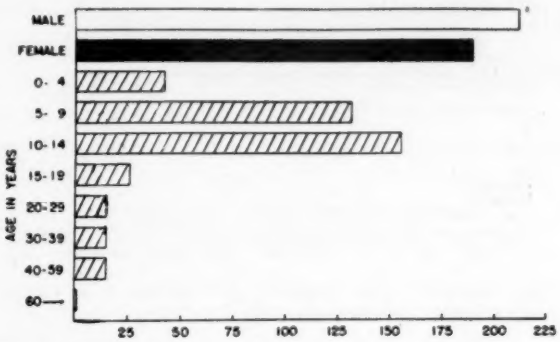

Fig. 1.—Distribution of patients by age and sex. One block equals 5 patients.

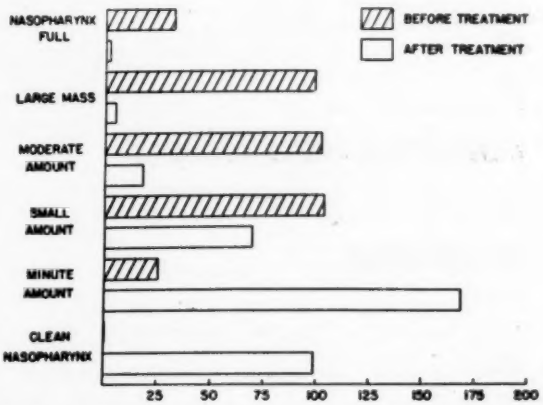

Fig. 2.—Patients showing given amounts of adenoids before and after treatments. One block equals 5 patients.

At the first examination 29 patients had normal eustachian orifices (fig. 3), and at the last examination 255 patients had normal eustachian orifices. At the first examination 147 patients had lymphoid tissue completely covering the eustachian orifices, and only 11 patients still had this condition on the last examination.

Seventy-one surgical removals of lymphoid tissue were carried out on these 400 patients during the period of observation. One hundred

and ninety-one patients had had surgical removal of lymphoid tissue before their first visit to the clinic.

Changes in the Patient's Symptoms.—Hearing was measured with a 2A Western Electric audiometer (in a soundproof room when possible). The frequencies considered in the following figures are 256,

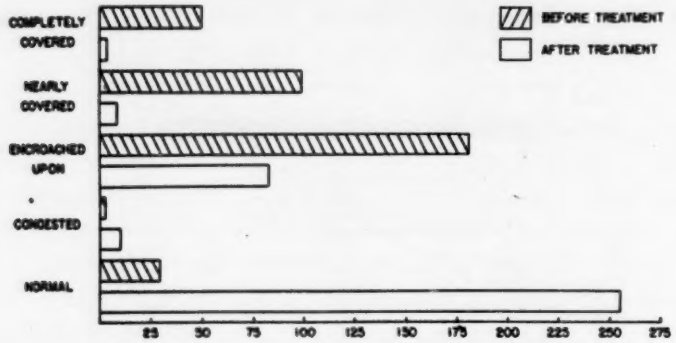

Fig. 3.—Patients showing given degree of interference with eustachian orifices before and after treatments. One block equals 5 patients.

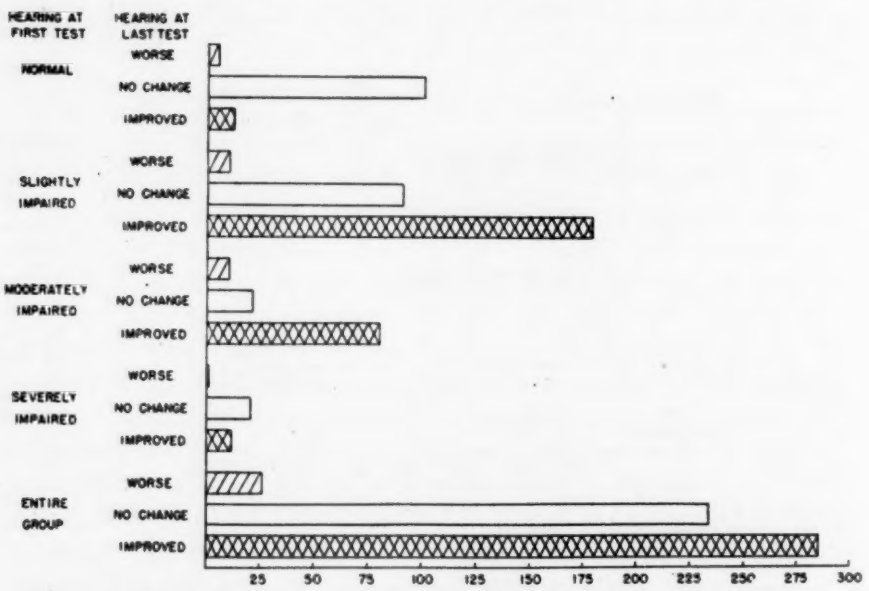

Fig. 4.—Ears showing given changes in hearing during treatments. One block equals 5 individual ears.

512, 1024, 2048, 4096 and 8192 cycles per second. Patients with no threshold higher than 20 decibels were considered to have normal hearing. Those patients with threshold for one or more tones higher than 20 decibels but no three thresholds above 30 decibels were considered

to have slight impairment of hearing. If the thresholds for three or more tones were higher than 30 decibels, the impairment was called moderate. If the thresholds for three or more tones were higher than 50 decibels, the patient was considered to have severe impairment of hearing. When changes on subsequent audiograms were consistent and an improvement of 5 decibels or more on four or more tones or 10 decibels on two or more tones was demonstrated, the hearing was said to be improved. If the reverse was true, the hearing was said to be worse. Changes of less magnitude and inconsistent changes were disregarded. Changes in hearing are tabulated by individual ears—not by patients.

Audiometer tests were performed two or more times on 542 ears during this period (fig. 4). On the first test, 119 ears were normal, 280 were slightly impaired, 111 were moderately impaired and 32 were

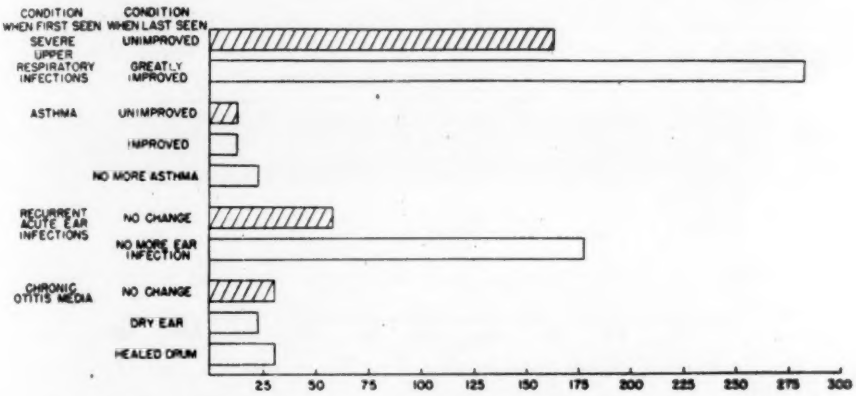

Fig. 5.—Patients with infections of the upper respiratory tract, asthma and infections of the ears who showed given results. One block equals 2 patients.

severely impaired. At the last test, the hearing of 234 ears had remained unchanged (101 of these were normal on the first test), the hearing of 284 had improved, and in only 24 had the hearing grown worse.

Of 33 chronically discharging ears, 12 healed completely during the period of observation, 9 became dry though perforations persisted, and 12 continued to run (fig. 5). Of 94 patients who suffered from frequent acute aural infections, 71 ceased to have infections.

Of 178 patients subject to unusually frequent and severe acute infections of the upper respiratory tract, 113 stopped catching colds completely or had few, mild colds. Of 19 patients with bronchial asthma, 9 no longer had attacks, and 5 others were markedly improved.

Seventy-six patients received only a single radium treatment; 1 patient had nine treatments and 1 has had ten treatments (fig. 6).

It is of importance that such results as are reported here be compared with results in an adequate control group of patients. Such a group is difficult to obtain as those most in need of help can hardly be refused treatment. At the Hagerstown Clinic there have been a few patients who have refused the recommended therapy. These patients are being followed as adequately as possible, and a report on them will be prepared when the follow-up periods are adequate to make the group comparable with the treated group.

DEVELOPMENT OF RADON TREATMENT

Surgical adenoidectomy is by itself an unsatisfactory solution of this problem for the following reasons:

1. It is almost impossible to eliminate surgically all the nasopharyngeal lymphoid tissue.

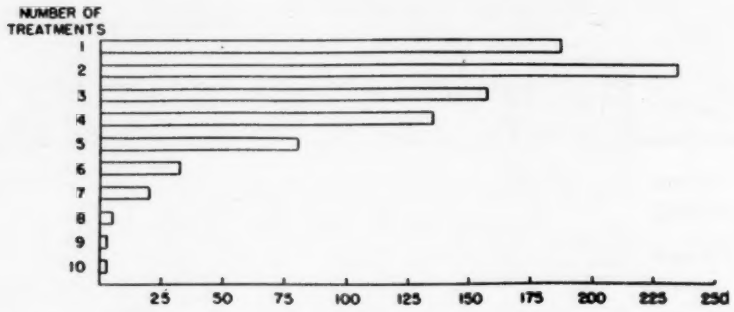

Fig. 6.—Patients having given number of radium treatments. One block equals 2 patients.

2. Radical attempts at total surgical adenoidectomy may result in damage to the eustachian orifices.
3. Even if all lymphoid tissue could be removed, the mucous membrane which grows in over the denuded nasopharynx contains lymphoid tissue as an integral part of its stroma.
4. The minutest nodules of lymphoid tissue are capable of growing rapidly to large size under the stimulus of infection or of allergy.
5. Even small remnants of lymphoid tissue may serve as foci of infection, or, if strategically placed, may obstruct the eustachian orifices.

Any one who carefully and routinely examines the nasopharynx at various intervals after an adenoidectomy will readily find confirmation of the foregoing statements.

It was with these facts in mind (and with the knowledge that lymphoid tissue shows a high degree of susceptibility to radium emanations)

that Dr. Crowe, at the Johns Hopkins Hospital,[1] over twenty years ago, began to treat recurrent adenoids with direct applications of radon-containing applicators. From the beginning it was apparent that this was a simple and effective way of eliminating lymphoid tissue from the nasopharynx; but it is only in recent years that the far reaching benefits of this mode of treatment have been more fully (although probably not yet completely) realized.

Until 1943 this therapy was administered by means of radon-containing applicators with 1 mm. of brass as filter; thus mostly gamma rays were obtained. In 1943 a clinic for the prevention of deafness in children was opened in Hagerstown, Md.[2] In an attempt to provide a practical form of radiation therapy to be used in localities where radon was not easily available (and on the advice of Dr. Curtis Burnam), the equivalent of 0.3 mm. of monel metal was used as filter, which provided a large percentage of beta rays and reduced the time factor for the treatment. This type of radiation therapy has been used at the

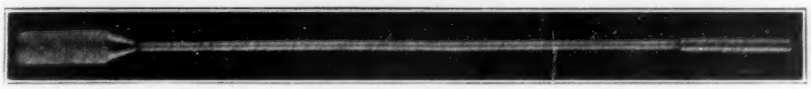

Fig. 7.—The applicator.

Hagerstown Clinic for over three years and has also been used by the United States Army Medical Corps in the treatment of aerotitis of thousands of Army Air Corps personnel.[3]

TECHNIC OF THE RADIUM TREATMENT

1. The applicator contains 50 mg. of radium sulfate in a cylinder permanently attached to a thin rigid handle 25 cm. long. The filter is 0.3 mm. monel metal (fig. 7).

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1. Crowe, S. J., and Burnam, C. F.: Recognition, Treatment, and Prevention of Hearing Impairment in Children, Ann. Otol., Rhin. & Laryng. **50**:15-31 (March) 1941. Burnam, C. F.: Irradiation Treatment of Hyperplastic Lymphoid Tissue, Laryngoscope **50**:663-670 (July) 1940. Crowe, S. J.: The Local Use of Sulfadiazine, Radon, Tyrothricin and Penicillin in the Treatment of Ear, Nose and Throat Disease, Ann. Otol., Rhin. & Laryng. **53**:227-241 (June) 1944.

2. Proctor, D. F., and Willard, W. R.: Washington County (Maryland) Program for the Prevention of Deafness in Children, Arch. Otolaryng. **43**:462-472 (May) 1946. Proctor, D. F.: Irradiation for the Elimination of Nasopharyngeal Lymphoid Tissue, ibid. **43**:473-480 (May) 1946.

3. Fowler, E. P., Jr.: Irradiation of the Eustachian Tube: An Anatomic, Physical and Clinical Study of a Treatment for Recurrent Otitis Media Applied to Aero-Otitis, Arch. Otolaryng. **43**:1-11 (Jan.) 1946. Mikell, J. S.: The Use of Radium in the Aerotitis Control Program of the Army Air Forces, Ann. Otol., Rhin. & Laryng. **54**:708-715 (Dec.) 1945.

2. Each side of the nose is anesthetized by passing a small cotton applicator with a few drops of a 2 per cent solution of tetracaine hydrochloride (Pontocaine) along the floor of the nose into the nasopharynx.

3. The nasopharynx is carefully examined with the electric nasopharyngoscope, and a notation is made of the appearance of the adenoids and of the eustachian orifices.

4. One radium applicator is passed into the nasopharynx on each side of the nose so that its distal end will be in contact with the adenoid tissue (fig. 8).

5. A timer alarm clock is set for nine minutes, and the physician goes quickly at least 10 feet (3 meters) away from the patient.

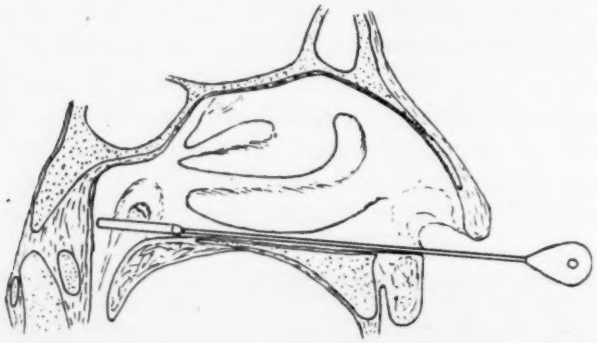

Fig. 8.—Applicator in position. (From Crowe, S. J.: Irradiation Treatment of Hyperplastic Lymphoid Tissue in the Nasopharynx, in Jackson, C., and Jackson, C. L.: Diseases of the Nose and Ear, Philadelphia, W. B. Saunders Company, 1945.)

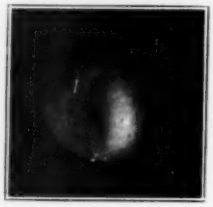

Fig. 9.—Picture of a clean nasopharynx.

6. At the end of nine minutes, each applicator is removed from the nose, quickly cleaned with some automatic cleaning device and replaced in its lead chamber.

7. Treatments are repeated at intervals of three weeks until a satisfactory result has been obtained or until four treatments have been given (fig. 9). If at the end of four treatments further irradiation is indicated, a delay of six to twelve weeks is usually advisable, since in many patients further regression of the lymphoid tissue will occur in this time. If satisfactory results are not obtained after six to eight treatments, the physician may suspect the diagnosis and should carefully review all of the facts of the case.

8. All of this treatment can be carried out quite painlessly and usually with the willing cooperation of even 4 or 5 year old children. When a child is unco-

operative, the parent (not the physician or the nurse) should hold the child during treatment.

9. The physician should at all times stay as far away as possible from the radium-containing chamber and never touch this chamber with his fingers.

INDICATIONS FOR, AND PRELIMINARIES TO, THERAPY

1. Infected or enlarged adenoids as seen by electric nasopharyngoscopic examination is the sine qua non (fig. 10).

2. Chronic infection of tonsils or sinuses must be treated simultaneously with, or cleared up before, radium therapy.

3. Severe allergies should be properly handled during or before therapy.

4. When the tonsils are infected, or there is a large mass of adenoids, or rapid elimination of adenoids is desired, irradiation should be preceded by tonsillectomy or adenoidectomy or both.

5. Treatments should not be given during acute infections of the upper respiratory tract.

6. Deafness apparently associated with obstruction of the eustachian tube is a clear indication for treatment.

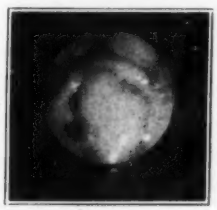

Fig. 10.—Picture of enlarged adenoids. (From Hendricks, J. E., and Lieberman, A. T.: Activities of the Irradiation Clinic at Westover Field, Massachusetts, Ann. Otol., Rhin. & Laryng. **54**:663 [Dec.] 1945.)

7. Chronic infection of the ear, recurrent acute infection of the ear, recurrent acute infection of a sinus, recurrent acute infection of tonsils (associated with preceding nasopharyngitis), recurrent acute colds, postnasal discharge without other cause are all, usually, amenable to this type of treatment.

8. Mouth breathing due to obstructive masses of adenoids will subside when breathing space is restored.

9. Bronchial asthma, thought to be wholly or partly on an infectious basis, especially when attacks are preceded by infections of the upper respiratory tract, is usually greatly helped.

CONCLUSIONS

1. Adenoidectomy is not in itself a completely satisfactory answer to the problem of infected and enlarged nasopharyngeal lymphoid tissue.

2. Irradiation of this tissue with radium emanations is a valuable adjunct to surgical removal and is often of great help by itself.

3. Good results have been obtained by radium irradiation of the nasopharynx combined with adenoidectomy or other orthodox methods of treatment—or by radium irradiation alone—in the treatment of:

(*a*) Deafness due to chronic interference with the function of the eustachian tubes.

(*b*) Recurrent infections of the upper respiratory tract.

(*c*) Recurrent acute infection of the ear.

(*d*) Chronic infection of the ear.

(*e*) Bronchial asthma.

6 East Eager Street.

FENESTRATION FOR OTOSCLEROSIS

Report of One Hundred and Twenty-Three Cases

ROBERT L. MOORHEAD, M.D.
BROOKLYN

THAT the Lempert fenestration operation will restore practical, serviceable hearing to a large percentage of patients with clinical otosclerosis is no longer doubted except by a few of the most skeptical otologists. That the improvement of hearing is permanent is probable. I have patients, operated on over four years ago, who have retained good hearing, and Lempert has patients whose improvement has lasted over seven years. Objection is made by some that those who treat by this method do not remove the cause of otosclerosis, and this objection is certainly true, but that is no reason why otologists should allow patients to be handicapped by their deafness. Clinical otosclerosis becomes manifest when the base of the stapes becomes more or less fixed in the oval window. Regardless of the amount of active otosclerosis in the surrounding areas of the labyrinthine capsule, deafness does not manifest itself until this fixation takes place. Politzer's description of the disease, written in 1897, describes the clinical picture and is still unchanged now, forty years later. One does know that during these years no treatment of any kind, including vitamins, diets, various drugs and glandular preparations, has ever succeeded in restoring the hearing in a case of otosclerosis and that cases of this disease were practically hopeless from a therapeutic standpoint until the fenestration operation was developed. Now, although nothing is known of the cause of the bony changes, one is able to remove the effect of these changes by operative measures. One does not know the cause of various other conditions in the body, but that is no reason why the patient should not be relieved of his complaint.

What cases are suitable for operation? At first it was assumed that a normal ear drum and a history indicating that the middle ear had not previously been infected were essential to the successful performance of the operation. Otologists now consider that this was too narrow a requirement, and so far as the middle ear is concerned, if it is intact, the drum may be thickened and sclerotic or scarred from previous damage and the ear may still be suitable for operation. Only a definite perfora-

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tion excludes the case so far as the middle ear is concerned. Even a previous mastoidectomy, provided the ear is well healed and free of infection, does not exclude the operation. The disease is characterized by an insidious onset, is bilateral, is usually accompanied by tinnitus—and over 50 per cent of the patients show paracusis. The eustachian tube must be patent. The most important points in the determination of suitability for operation are the audiometric and tuning fork tests. In

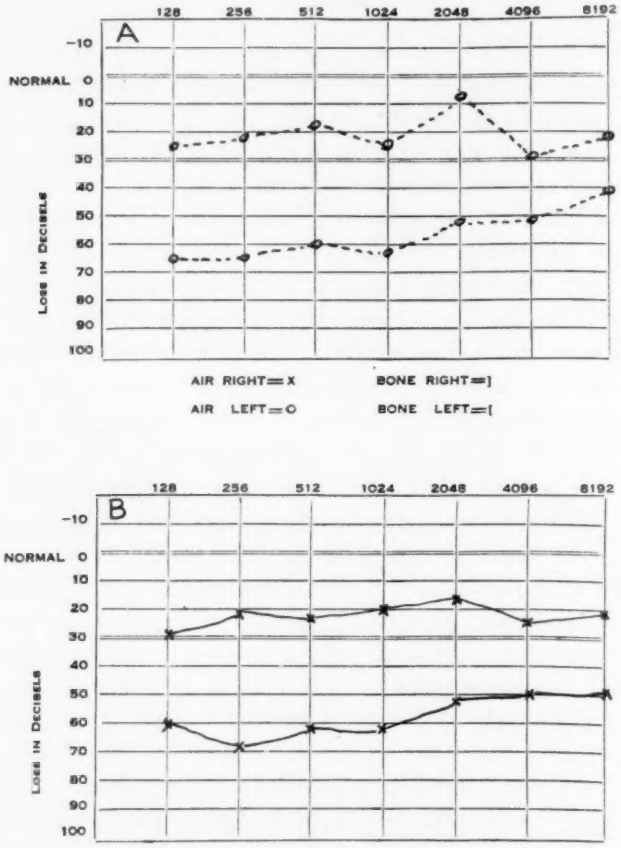
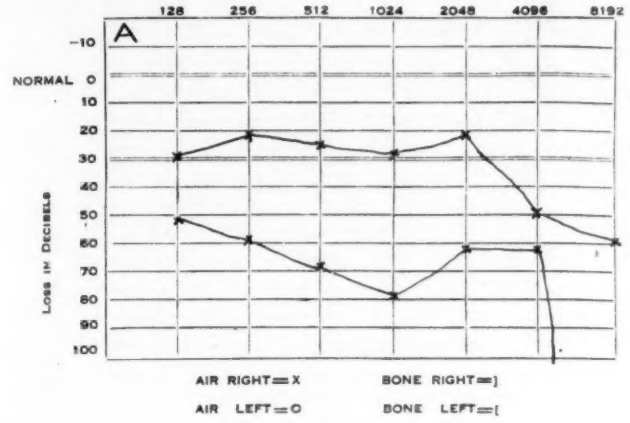


Chart 1.—*A*, hearing before and four years after operation in Mr. E. F., aged 25 (case 10). Operation performed on Jan. 30, 1942 (very active fistula).

B, hearing before and more than four years after operation in Miss G. G., aged 31 (case 11). Operation performed on Nov. 7, 1941 (active fistula).

general, patients who are candidates for this operation should have diminished hearing by air conduction while at the same time preserving good bone conduction. It is well established that in patients with otosclerosis the auditory nerve eventually degenerates, although the cause of this degeneration has never been definitely determined. It is assumed that the loss of hearing by bone conduction indicates the amount of

nerve degeneration; therefore it is required that the bone conduction be relatively good in the conversational frequencies to qualify a given patient as suitable for operation. It is not important how low the perception may be by air conduction provided the perception by bone conduction has not greatly diminished. If, however, the hearing for bone-conducted sound is also seriously diminished, the chances of improving the patient's hearing by operation are relatively poor.



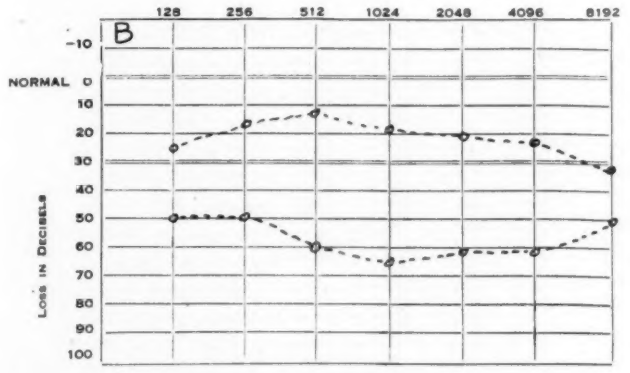


Chart 2.—*A*, hearing before and three years after operation in Mrs. C. K., aged 55 (case 16). Operation performed on Oct. 21, 1942.
B, hearing before and three and a half years after operation in Mrs. M. B., aged 25 (case 22). Operation performed on July 2, 1942.

It should be understood that there are three classes of patients on whom the fenestration operation has been performed: 1. Otosclerotic patients with good hearing for bone-conducted sound. These are the ideal ones and of course should give the highest percentage of good results. 2. Otosclerotic patients with marked nerve degeneration which has not, however, progressed to a sufficient degree to warrant the

assumption that no improvement of hearing will be obtained. Included in this class are many who are along in years (40 to 58) and who either know of some one who has had a good result or who for one reason or another (e. g., loss of employment) wish to have the operation performed on the chance of improving their hearing. 3. Patients with marked nerve degeneration who wish to take the chance or on whom the otologist wishes to operate for one reason or another. Opera-

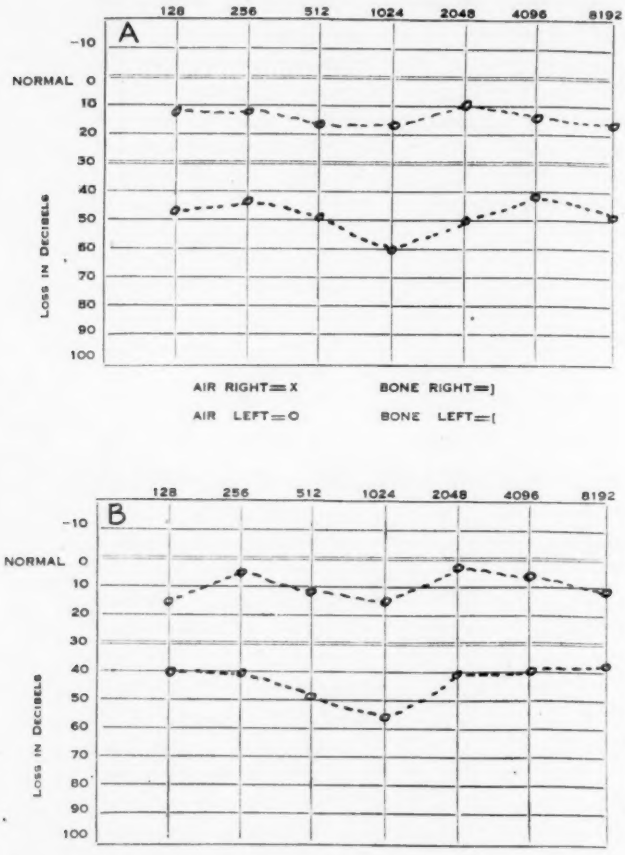
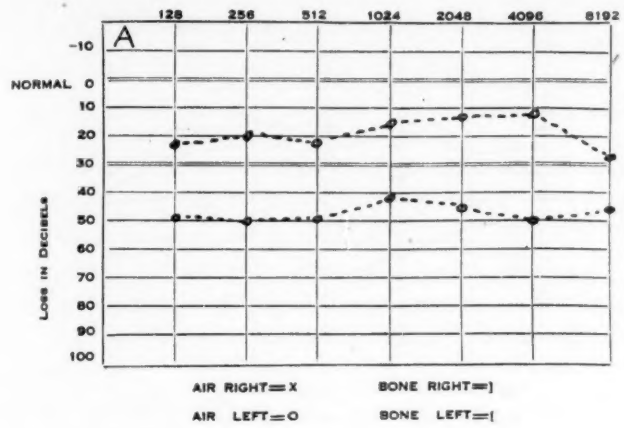


Chart 3.—*A,* hearing before and two years after operation in Miss V. F., aged 34 (case 10). Operation performed on Jan. 12, 1944.

B, hearing before and two years after operation in Miss S. S., aged 19 (case 12). Operation performed on Jan. 28, 1944.

tion is perfectly justified in this last class for, if it is properly performed, even though no hearing improvement is obtained, these patients are in no way worse than before the operation. In all classes one usually operates on the poorer ear, so that if no improvement takes place, one does not further handicap the patient.

In favorable cases, poor results seem to be from two main causes: (1) closure of the new window by formation of new bone or by development of fibrous tissue or by both; (2) secondary postoperative serous labyrinthitis—a reaction which takes place to some extent in every case in which the membranous labyrinth is exposed. In a general way the younger patients seem to be much more prone to have the window close by bone regeneration than patients in the older brackets. This can be



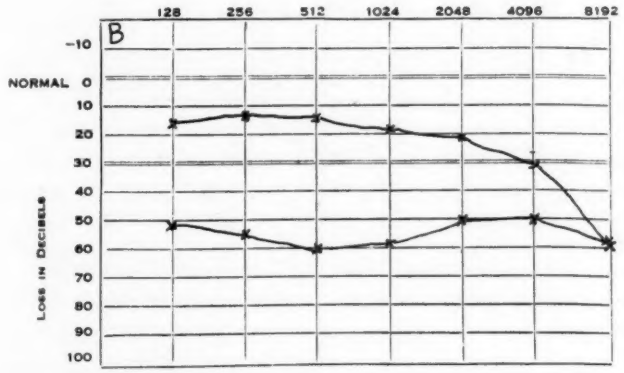
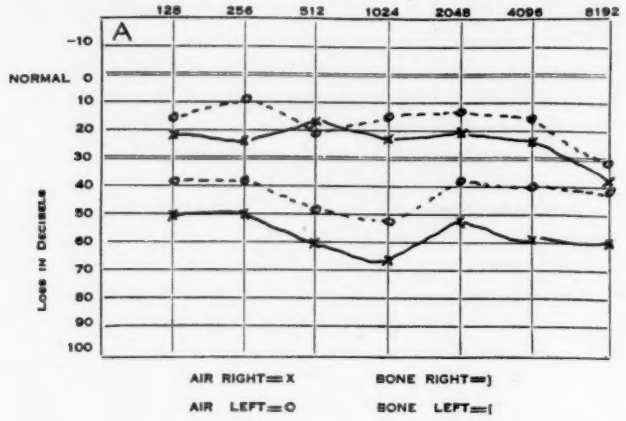


Chart 4.—*A*, hearing before and more than two years after operation in Mrs. F. M., aged 35 (case 13). Operation performed on Sept. 24, 1943.

B, hearing before and eighteen months after operation in F. T. A., aged 27 (case 11). Operation performed on June 16, 1944.

readily understood when one considers that the processes of bone repair are much more active in the young. Closure of the new window can be caused by formation of new bone or by development of fibrous tissue or by both, and it is often not possible from a clinical standpoint to determine accurately whether the closure is due to one or to the other.

Lifting the flap and inspecting the area is the only way to ascertain this. If the closure is due entirely to bone formation, the new bone may be removed with some chance that the window will remain open, but if the closure is due to formation of fibrous tissue, nothing can be done, for the membranous labyrinth will be found to be adherent to this fibrous tissue and attempts to remove the latter will only cause tearing of the membrane with the result a dead labyrinth. It has been considered by many



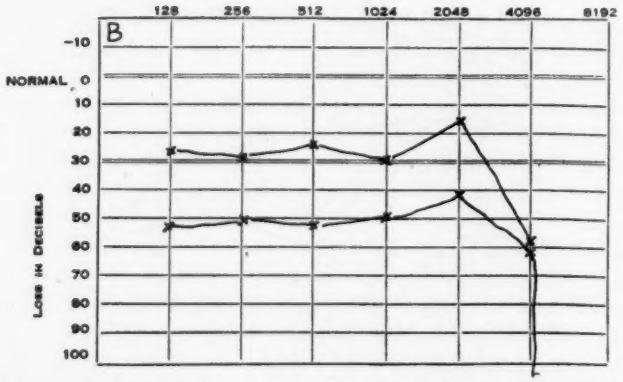


Chart 5.—*A*, hearing before and after operation in Miss S. McC., aged 26 (case 15): right ear, three years after operation; left ear, eighteen months after operation. Operation on right ear performed on Feb. 13, 1942; that on left ear, June 2, 1944.

B, hearing before and two and a half years after operation in Mr. B. S., aged 35 (case 14). Operation performed on June 18, 1943.

that the chief cause of the operative failures is this secondary closure of the window. This perhaps was true when the opening was made in the horizontal canal, but it is my opinion that an equally important cause of the failures at present is secondary labyrinthitis. It is possible that

the extent of this can be somewhat controlled by the use of the cartilaginous stopple and by chemotherapy, but until some means are devised to overcome this reactionary inflammatory process, otologists will always have a definite percentage of failures that can be ascribed to it. Failures due to secondary closure of the window can be distinguished from those due to labyrinthitis, for in cases of secondary closure the hearing is good for a variable time after operation and then, after several months, slowly diminishes so that eventually the patients' hearing goes back to the preoperative level. In cases of labyrinthitis the hearing does not improve and then fail—it never improves at any stage.

COMPLICATIONS

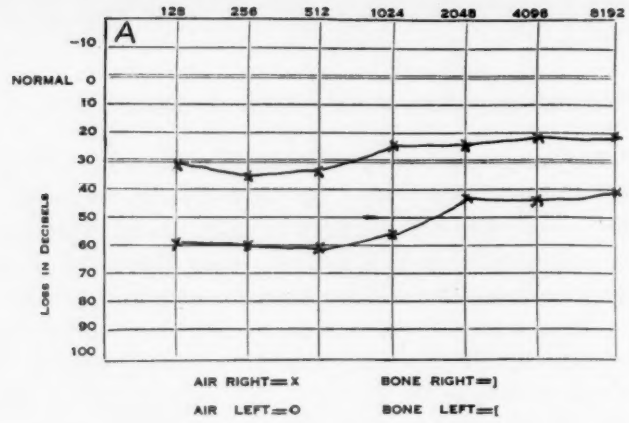
There have been no deaths in the series and only a single patient who caused any concern. This patient, a woman of 42, began to have signs of some intracranial disturbance, variously diagnosed as hemorrhage, cerebral edema and other conditions. Eventually she made a perfectly good recovery and is now teaching school, but she has an entirely dead labyrinth. The exact nature of her trouble was never determined.

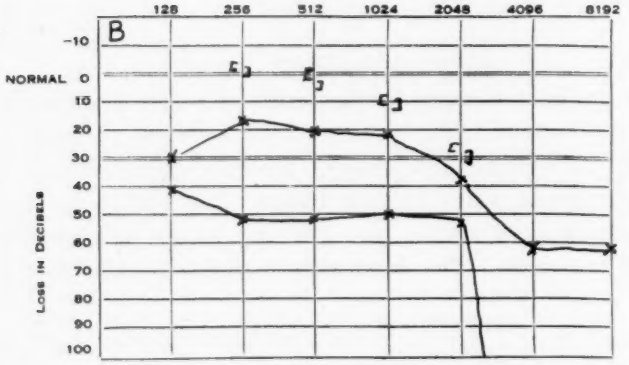
Facial Paralysis.—There have been no cases in which permanent facial paralysis resulted, but there have been 2 cases in which transient facial paresis was produced, developing on the third postoperative day and disappearing at the end of a week in one instance and developing on the fifth postoperative day and requiring almost six months to disappear completely in the other.

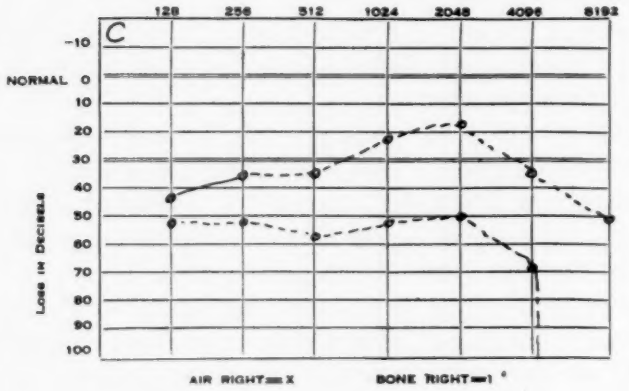
Perichondritis.—There was a single case in which postoperative perichondritis was observed. This was a painful and annoying complication, but under chemotherapy it responded in about two weeks, and the patient now has excellent hearing. However, after two years there is still a slight discharge from the cartilaginous area.

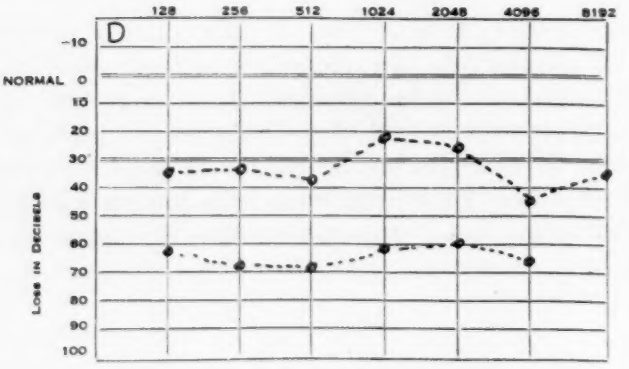
Vertigo.—There have been no cases in which vertigo was persistent. The postoperative disturbance of equilibrium has usually disappeared promptly, but one patient had some disturbance for about two months. This was the longest duration in any case in the series.

Discharge from the Fenestrated Ear.—In spite of most careful operative technic and postoperative care, there have been occasional cases in which the discharge from the ear persisted. It is not possible for one to determine accurately the exact number of these but it is probably close to 10 per cent of the total. In no case has the discharge been profuse, but a number of patients have complained of the annoyance of a moist ear. Improved technic should substantially reduce the number of cases in this category.









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RESULTS

The results are estimates based on audiometric readings in the frequencies of 512, 1024 and 2048 cycles. These will be referred to as the three tones when the results are analyzed. Furthermore, hearing of any one of these tones is considered good only when, regardless of the preoperative level, the threshold of perception is not more than 30 decibels below normal. The number of decibels of improvement is of little value to the patient unless the 30 decibel level is reached.

Of the 123 consecutive patients operated on, 39, or 29 per cent, failed to recover satisfactory hearing for any of the three tones, and in these the results should be regarded as just plain failures. The percentage was higher for the early patients—8 of the first 15 patients were in this group—but even in the later patients there were never lower than 25 per cent failures. This is partly explained by the fact that one is constantly operating on patients whose outlook is far from ideal and who have a variable amount of nerve degeneration at the time of operation. If one could avoid operating on such patients, the percentage of good results would naturally be much higher, but the percentage of good results is only a secondary consideration, the main object being the possibility of restoring practical hearing to the largest number. It is surprising the number of these patients, even of those with poor prospects, who can be rehabilitated.

In spite of the fact that 29 per cent of the patients in the series failed to recover any hearing, only 5 had the hearing diminished below the preoperative threshold. Thus it is readily seen that, even though no improvement occurred, these patients were not damaged in any way and that their perceptive status was just as good after as before operation. Barring accident, one can be fairly sure that the fenestration operation will not harm these patients.

Good Results.—Group 1: Of the 123 consecutive patients, 57, or 47 per cent, recovered serviceable hearing with perception at the 30 decibel level or better for all three tones. The patients in whom this level has been maintained are all more than seven months past their

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EXPLANATION OF CHART 6

Audiometric records of patients who have good hearing but whose threshold for one of the conversational frequencies is below 30 decibles.

A, hearing before and about two years after operation in Miss S. B., aged 24 (case 11). Operation performed on Oct. 22, 1943.

B, hearing before and more than two years after operation in Mrs. R. S., aged 40 (case 12). Operation performed on June 25, 1943.

C, hearing before and one year after operation in Miss A. F., aged 30 (case 6). Operation performed on Nov. 1, 1944.

D, hearing before and three years after operation in Mrs. M. De F., aged 36 (case 12). Operation performed on Nov. 6, 1942.

operation, the lapse of time varying from seven months to over four years. Here, again, the early results considerably lowered the percentage, and among 50 later consecutive patients (cases 50 to 100) the percentage showing excellent hearing rose to 56. Again it should be remembered that this group included several patients with frank nerve degeneration and several with borderline conditions who for one reason or another elected to be operated on. If these, whose chances were unfavorable at the onset, are eliminated a much higher percentage of good results can be shown, but as this paper deals with consecutive patients of all kinds, I shall consider only the 47 per cent.

Group 2: There was another group of patients whose threshold for two of the three tones reached the satisfactory level of 30 decibels or better but whose perception of one of the three tones remained below this level (although the average of the audiometric readings for the three was 30 or better). In this group there were 19 patients (15 per cent), and in a general way they should be classed as showing good results even though they do not quite reach the standards set by the otosclerotic group with which I am associated. All of these patients are conscious of a considerable improvement in their hearing; 3 who wore hearing aids previous to operation have discarded them. It is a fact worthy of note that in the cases in which the improvement of hearing for one tone fails to reach the 30 decibel level, it is the 512 frequency that is most often concerned. No satisfactory explanation has as yet been advanced to account for this peculiarity. Perhaps further observation will furnish the clue.

Group 3: This includes the patients in whom hearing is improved over the preoperative level but in whom only that for one of the three tones has reached to or above the 30 decibel level. There are 11 patients (9 per cent) in this group, and although these cannot be classed as showing good results by the standards which I have mentioned, 3 of them are among my most grateful patients and 1, a school teacher, has been enabled to continue work when otherwise she would have been forced to retire.

In general, groups 1 and 2 should be classed as enjoying successful results (62 per cent) whereas group 3 should be classed with those in whom the results were poor or failures (38 per cent). Again it should be remembered that these figures are for the results in consecutive patients, not selected ones, and include those having nerve degeneration of a varying degree. If otologists ever reach the point where they will operate only on patients with no degeneration of the auditory nerve, results from a percentage standpoint will be materially higher, but they will miss the satisfaction of restoring hearing in many persons who otherwise are doomed to a life of deafness.

Effect of Use of Stopple.—Starting in February 1944, I used the cartilaginous stopple in 24 cases. In 19 of these the hearing by bone conduction was good and the outlook should have been good, and in 5 cases the hearing for bone-conducted sound was considerably reduced, with a doubtful outlook. Of the 19 patients, 10 had excellent results, and their good hearing has been maintained up to the present. In 4 patients hearing has been vastly improved, but in each of these the hearing for one tone has failed to reach the 30 decibel level. In 2 patients the hearing was improved but has since declined to the preoperative level and apparently there has been bony closure, while in the remaining 3 of the 19 patients the results are total failures, with no improvement in hearing noticed at any time. Thus there have been five real failures. Of the 5 patients with unfavorable prospects, 3 observed no results whatever and 2 had their hearing improved but not to the extent that the results could be called excellent. It will therefore be seen that the final results with the cartilaginous stopple were not markedly different from those in patients operated on without it. However, results obtained in such a small series of patients cannot be conclusive. There is no doubt that the stopple prevents, to a large extent, the immediate postoperative drop in hearing so often seen in patients without it, and as this drop is commonly believed to be due to serous labyrinthitis, the more one can avoid this reaction, the better should be the final results.

One interesting case was that of a girl of 16 who was operated on in 1944. She had good hearing for several months, and then the hearing was gradually lost. On revision, in April 1945, complete bony closure was found. The new bone was removed and a cartilaginous stopple inserted. She has retained good hearing up to the present time (nine months).

Operation vs. Hearing Aids.—There are still some otologists who state that a well fitted hearing aid will give as serviceable hearing as a fenestration operation. Perhaps the best answer to this is the one given by the patients themselves, for a good percentage of these patients were wearing hearing aids at the time of their preoperative examination and desired to rid themselves of the appliance. The aid is a handicap both socially and economically, as well as being cumbersome, and young patients, especially, feel that it serves to advertise their misfortune and use it only with great reluctance. I have questioned many who have discarded their aids and have yet to find one who would have preferred to remain as before operation.

Since July 1938, when the first report on the one stage operation was published by Lempert; many modifications of the original procedure have been tried and several adopted. Originally the new window was

placed in the horizontal semicircular canal, but later that location was abandoned in favor of a window farther forward, in the surgical dome of the vestibule. Two years ago, Lempert advocated the insertion of a movable cartilaginous stopple. Now the perforated stopple is being used. These various changes were made not because the operation was not successful but in an attempt to obtain better results in a higher percentage of patients. It is probable that in the course of time various other modifications will be advocated, especially as more and more men are developing the technic of the operation. These men, in various parts of the country, will undoubtedly help to discover various factors that will add to the success of the procedure.

SUMMARY

The fenestration operation can be performed without risk to life or serious complications.

Of 123 consecutive patients of all kinds on whom this operation was performed, 62 per cent recovered good serviceable hearing.

125 Remsen Street.

THE COCHLEOGRAM AND ITS CLINICAL APPLICATION

A Preliminary Report

JULIUS LEMPERT, M.D.
NEW YORK
AND
ERNEST GLEN WEVER, Ph.D.
AND
MERLE LAWRENCE, Ph.D.
PRINCETON, N. J.

SINCE the advent of the Lempert fenestration operation [1] for the restoration of practical and serviceable hearing in patients with clinical otosclerosis, the necessity for the development of an objective test by which to determine preoperatively the existing reservoir of cochlear function in a deafened ear has become quite obvious. However, not until the tympanosympathectomy technic [2] for the relief of tinnitus aurium was first introduced did the development of such a test enter the realm of possibility. Since tinnitus is not infrequent in people with normal hearing and since the tympanosympathectomy technic permits the placing of specially devised electrodes against the round window membrane, it is hoped that a standardized normal electrical cochleogram can be developed so that any deviations from the normal can eventually be studied and recognized.

Drs. Wever, Lawrence and I are now engaged in an attempt to develop a practical and safe means for obtaining cochleograms so that hearing defects can be studied and diagnosed objectively without the patient's influence.

Since 1930 the electrical potentials which arise in the cochlea in response to sounds have been observed in a great variety of experimental animals, and their study has aided in numerous ways in the advancement of our understanding of hearing. This report deals with these potentials as observed in man and the possibility of their clinical application.

From the Lempert Research Foundation, Inc.

This article was read before the Otosclerosis Study Group in Chicago on Oct. 13, 1946.

1. Lempert, J.: Improvement of Hearing in Cases of Otosclerosis: A New, One Stage Surgical Technic, Arch. Otolaryng. **28**:42-97 (July) 1938; Fenestra Nov-Ovalis: A New Oval Window for the Improvement of Hearing in Cases of Otosclerosis, ibid. **34**:880-912 (Nov.) 1941.

2. Lempert, J.: Tympanosympathectomy: A Surgical Technic for the Relief of Tinnitus Aurium, Arch. Otolaryng. **43**:199-212 (March) 1946.

The use that we can make of the electrical phenomena in the investigation of hearing depends on the point at which they originate in the ear and the part they play in the process of sound reception. From many studies it is now well recognized that the effects have their locus in the inner ear and that they stand in intimate relation to the excitatory action of acoustic stimuli. Specific details of the origin and the nature of the potentials are less certain, but there is considerable weight of evidence that they arise in the activity of the hair cells of the organ of Corti.

This evidence comes from a number of studies of pathologic conditions, both spontaneous and experimental, in which a correlation is found between abnormalities in the sensory structures and impairments of electrical activity.

Studies have been made of four species of animals in which hereditary deafness is exhibited: certain albino cats,[3] a strain of Dalmatian dogs,[4] a breed of mouse known as the shaker-1 mutation[5] and a breed of "waltzing" guinea pigs.[6] All these animals fail to react to sudden sounds in the fashion usual to normal individuals, and thus appear to be clinically deaf. All when examined for cochlear potentials show absence or serious impairment of these responses. And finally, when the ears are subjected to histologic examination, all present a gross pathologic alteration of structures of the scala media. While the different preparations vary somewhat in detail, they all agree in showing distortion of the organ of Corti with atrophy of hair cells which in extreme stages becomes complete, together with shrinkage and partial atrophy of the stria vascularis. Other structures—the tectorial membrane, Reissner's membrane, nerve fibers and ganglion cells—show changes in some of the animals but not in all. These structures therefore are excluded as the source of cochlear potentials. The stria vascularis is hardly a likely source both because of its structure and position and because in all cases its atrophy is only partial. However, its constant involvement is probably significant; indeed, it is likely that the further pathologic change results because this structure has failed in its normal function as a nutritive center for the sensory apparatus.

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3. Howe, H. A., and Guild, S. R.: Absence of the Organ of Corti and Its Possible Relation to Electric Auditory Nerve Responses, Anat. Rec., 1932-1933, supp. 55, pp. 20-21. Howe, H. A.: The Relation of the Organ of Corti to Audioelectric Phenomena in Deaf Albino Cats, Am. J. Physiol. **111**:187-191, 1935.

4. Hughson, W.; Thompson, E., and Witting, E. G.: An Experimental Study of Bone Conduction, Ann. Otol., Rhin. & Laryng. **45**:844-858, 1936.

5. Grüneberg, H.; Hallpike, C. S., and Ledoux, A.: Observations on the Structure, Development and Electrical Reactions of the Internal Ear of the Shaker-1 Mouse (Mus Musculus), Proc. Roy. Soc., London, s.B **129**:154-173, 1940.

6. Lurie, M. H.: Studies of the Waltzing Guinea Pig, Laryngoscope **49**: 558-565, 1939.

The evidence therefore points to the organ of Corti with its hair cells as the source of electrical potentials.

Further evidence comes from stimulation deafness experiments on guinea pigs, in which the animals are exposed to excessively loud sounds.[7] After exposure they show a serious loss of cochlear potentials, and histologic examination reveals disruption of the sensory apparatus. In milder cases the only injury is to the organ of Corti, especially in the region of the outer hair cells, and to the cells of the tympanic lamella, the cell layer that covers the tympanic surface of the basilar membrane. With stronger stimulation, the disruption is more extensive, and the basilar membrane is laid bare, while other structures, including the stria vascularis, are unaffected. In acute experiments the nerve fibers and ganglion cells remain, except that the dendritic processes extending into the organ of Corti are torn away.

It is further significant that in experiments carried out in cats [8] in which the cochlear nerve is sectioned intracranially the nerve fibers and ganglion cells undergo complete degeneration, but if the blood vessels that accompany the nerve have been spared, the sensory structures remain and the cochlear potentials are unimpaired. Hence it is abundantly clear that the cochlear potentials are not dependent on nervous elements; they are dependent only on the integrity of the sensory cells.

If the cochlear potentials arise in the hair cells as this evidence leads us to believe, there remains the question of the specific operation through which these potentials are generated. A reasonable hypothesis is that the oscillatory deformation of the cell occasioned by a vibratory stimulus produces a corresponding alteration of surface potential. This potential—or rather some small fraction of it—leaks away through the cochlear fluids and other conductive tissues to the active electrode and is recorded as the cochlear response.

In this recording the location of the active electrode is an important technical feature. Generally speaking, contact with the round window membrane yields the largest potentials. Contact with the cochlear capsule in an animal like the guinea pig, in which the bony wall is thin, gives good results also.

It will be evident that the recorded potential has only relative significance, since it is affected by the conductive path between the site of origin of the potential and the electrode. Moreover, since the hair cells are spread out along the cochlear spiral, any given position of the electrode cannot be equally effective for the various elements in action

7. Lurie, M. H.; Davis, H., and Hawkins, J. E., Jr.: Acoustic Trauma of the Organ of Corti in the Guinea Pig, Laryngoscope **54**:375-386, 1944.

8. Guttman, J., and Barrera, S. E.: Persistence of Cochlear Electrical Disturbance on Auditory Stimulation in the Presence of Cochlear Ganglion Degeneration, Am. J. Physiol. **109**:704-708, 1934.

for any one tone or for different tones. Consequently we cannot expect to find in the cochlear response a direct and absolute representation of the activity of the cochlear mechanism. Herein we must recognize a limitation of the electrical method. What we do have, however, is an indicator of activity of great relative significance. With a standard procedure we can determine the effects of all kinds of experimental and pathologic variations of the conductive mechanism, make comparisons between one ear and another in the same species of animal or even, with a little less assurance, make comparisons among different species.

A further limitation that must not be lost sight of lies in the relation to hearing in a broad sense. The cochlear potentials are representative of end organ activity but not of the behavior of the auditory nerve or the more central processes. The perception of sounds involves these central processes, and naturally is affected by them. In a given ear the cochlear action may be normal, and may yield a typical cochlear response, yet that ear may be functionally deaf, as was true of the cats in which the cochlear nerve had been destroyed, referred to in a foregoing paragraph.

On the other hand, the activity of the cochlea is essential to any further acoustic function, and if the cochlear potentials represent this activity, their impairment or lack must represent a functional loss. The albino cats and other deaf animals in which cochlear responses are lacking, although the nervous structures are intact, bear out this relationship.

In short, what we have in the cochlear response is a representation of inner ear activity, reflecting all the properties of the ear up to and including the hair cells, but representing them in relative and not absolute terms. With recognition of these limitations we proceed to a consideration of the electrical technic as a clinical tool.

A number of investigators have detected cochlear potentials in the human ear. The first to report were Fromm, Nylen and Zotterman,[9] in 1935. They worked with patients who had large drum perforations. They introduced through a perforation an electrode consisting of a fine wire wrapped about a bit of cotton. The potentials were amplified and led to a head phone or a loud-speaker. Positive results were obtained in 3 cases, most satisfactorily with the electrode in the niche of the round window. In 1 case an effect was said to appear with the electrode on the promontory or even on the walls of the auditory meatus or on the mastoid process.

More extensive tests were carried out by Andreev, Arapova and Gersuni [10] a short time later. They also used patients with a large

9. Fromm, B.; Nylen, C., and Zotterman, Y.: Studies in the Mechanism of the Wever and Bray Effect, Acta oto-laryng. **22**:477-486, 1935.

10. Andreev, A. M.; Arapova, A. A., and Gersuni, S. V.: On the Electrical Potentials of the Human Cochlea, J. Physiol. USSR **26**:205-212, 1939.

lesion of the drum and placed the electrode in the round window niche. After amplification the effects were recorded on a cathode ray oscillograph. Potentials were obtained over a tonal range from 200 to 2500 cycles, but they were only of small magnitude. In no case did they exceed 26 microvolts, and over the principal range they were but 1 to 8 microvolts, in response to sounds so loud as almost to be painful. When the electrode was moved to the bony surface near the round window niche, the potentials were seriously weakened, and at a distance of a few millimeters could no longer be detected. No responses were found in ears with hearing losses exceeding 50 decibels. In a few instances these investigators were able to obtain an oscillographic record of the potentials and they confirmed the usual observation of the animal experiments that the frequency follows that of the stimulus and at least roughly reproduces the latter's wave form.

More recent observations were made by Perlman and Case,[11] by a method similar to that already described. A cotton-tipped wire was used as electrode and inserted through a perforation of the drum into the round window niche. Most of the observations were made with head phones or loud-speakers. Positive results were obtained in 9 cases, in all of which the acuity of hearing was within 20 decibels of normal. Ears with more serious defects, common in the presence of large permanent drum perforations, failed to yield recognizable responses. Only rarely was it possible to obtain oscillographic records of the potentials. In general, electrode positions away from the round window gave feeble effects or none at all, but in 1 instance good responses were obtained on contact with the cochlear capsule near the apex.

The cited experiments have revealed in man a cochlear response of a character similar to that found in the lower animals. Our own experiments stand in confirmation of these, and, as already indicated, they have the further object of exploring the possibilities of the clinical use of these phenomena. Here we envisage their being used both for general diagnosis and for surgical guidance. Our present tests, therefore, are carried out in the course of operating on the ear.

For tests to be performed during operation it is necessary to provide thorough electrical shielding of the operating room.

The room used in our experiments has been lined throughout with stainless steel of heavy gage, and the material was applied with special care to secure good electrical conductivity over the entire enclosure. The shielding includes the door, and metal shutters are fitted to the window. It is further necessary during tests to break all connections of external power lines. These precautions have given us complete freedom from electrical disturbances.

11. Perlman, H. B., and Case, T. J.: Electrical Phenomena of the Cochlea in Man, Arch. Otolaryng. **34**:710-718 (Oct.) 1941.

The electrical equipment is housed in a control booth in an adjoining room. At one end is the stimulating apparatus and at the other the recording apparatus. The stimulating apparatus consists of an oscillator for generating sinusoidal currents over the audible range, attenuators for controlling intensity, an amplifier and power stage, and a loud-speaker for producing the sounds. The loud-speaker is of the type usually fitted to a horn, and in this case it is joined to a metal pipe about 1 inch (2.5 cm.) in diameter and 12 feet (3.5 meters) long. The pipe leads through the dividing wall and emerges through the ceiling of the operating room at a point just above the end of the operating table where the patient's head is placed. The recording apparatus consists of a 5 stage amplifier with a voltage gain of a thousandfold. It operates into a pair of head phones or a wave analyzer. The head phones serve for exploratory observations, while the wave analyzer, used as a selective voltmeter, gives opportunity for precise measurements over a range from about 1 microvolt upward. A cathode ray oscillograph is shortly to be added for visual observation and recording. The input of the amplifier is connected with a shielded cable that runs into the operating room and terminates at a jack fixed to a bracket above the operating table. A short (30 inch; 75 cm.) interconnecting cable has at one end a plug that fits this jack and at the other end a connection for an electrode cable. Several electrode cables are provided, each with two flexible wires, one ending in the active electrode and the other in the inactive electrode. The inactive electrode is a hypodermic needle that is inserted in the skin near the ear which is to be operated on. A good deal of experimentation has been carried out to determine the best type of active electrode; so far we have made most of the tests with a fine wire having a spherical bead at the end, formed by holding the wire for a moment in a flame. This wire is fixed to a heavier wire that serves as a handle, which in turn is soldered to the flexible wire lead. The electrode wire is fully insulated except for the bead at the end. The entire electrode cable and also the interconnecting cable are sterilized by autoclave, and the connection between electrode cable and interconnecting cable makes replacement of electrodes possible within the sterile field.

Unusual precautions are necessary in an experiment of this kind if one is to avoid all possibilities of artefact. There are many ways in which a false signal, indistinguishable in form from the cochlear response, can be introduced. When electrical sources of sounds are employed, there can be inductive and capacitative transfer of oscillations to the amplifier. The sounds themselves may cause vibrations of some part of the amplifier circuit which by varying the conductivity arouse electrical effects. Sounds may also produce such changes in tissues and fluids in the neighborhood of the electrodes. All these sources of error must be considered and guarded against. The purely electrical artefacts are handled by the shielding of the room and the thorough shielding of all apparatus and leads. Sounds that might act on the amplifier are controlled by soundproofing and shock mounting. Each of our early stages is enclosed in a heavy steel container which is suspended in a cast iron box, and this box in turn is suspended in a copper-lined wood case. The last-named source of difficulty, that of sounds acting on tissues, is not so amenable to mechanical control. Fortunately the effect is small

and does not obtrude itself so long as the sounds are moderate in intensity and the amount of amplification is not excessive. In the face of these difficulties, and especially the last, continued caution and vigilance and the free use of control tests are called for. By many tests, including experiments made on guinea pigs under conditions like those of the human experiments, we have satisfied ourselves that our precautions are suitable.

Our tests were carried out on 11 ears in the course of operations for otosclerosis, tinnitus or Ménière's disease. With the electrode inserted in the round window niche and probably in contact with the membrane, clearly positive responses were observed coming from 4 ears and faint responses from 2 others. The remaining ears yielded negative results, probably because of failure of the electrode to make contact with the round window membrane. Other placements occasionally tried, at the edge of the niche, on the promontory and at the newly opened fenestrum in the region of the ampulla of the horizontal canal, were unsatisfactory. Our observations thus confirm those previously reported that the round window membrane is the only suitable location for the electrode. Even here the potentials are small, yet in favorable cases they are sufficient for useful measurements.

No analysis of our results with respect to the audiograms of the ears will be attempted here, both because our data are few and because in these preliminary trials we have continually varied our method. Our aim has been to develop the most suitable technic for the experiments, especially as regards the form and the placement of the active electrode. Contact with the round window membrane is difficult to achieve, because the operative exposure presents only limited access to the niche, and the membrane lies deep in its recess at an awkward angle and out of view. We hope to develop a method whereby the electrode can be placed routinely and with certainty on the round window membrane.

If this technical objective can be attained, the next step will be to test many ears of various degrees of functional efficiency to discover the pattern of activity of the normal cochlea and its variations. The applications of the method then will follow.

119 East Seventy-Fourth Street.

TINNITUS AURIUM

Some Considerations Concerning Its Origin and Treatment

MILES ATKINSON, M.D., F.R.C.S.
NEW YORK

BEFORE attacking the subject with which this paper is concerned, noises in the ears, it may be wise to discuss for a moment head noises in general, in order to avoid confusion.

The term "tinnitus," meaning a ringing, should—strictly speaking—be reserved for the symptom of ringing in the ears (tinnitus aurium). Using the word in the more general sense, however, as it commonly is used, to comprise all varieties of head noises, one may divide the causes of this symptom into two main classes—extrinsic and intrinsic.

Extrinsic or false tinnitus results from disturbances which arise outside the auditory tract, and includes not only extraneous sounds but also the large group of psychogenic disturbances. Intrinsic or true tinnitus is the result of some disturbance within the auditory tract itself.[1] The two classes can usually be readily distinguished by certain clinical features: the character of the noise—for instance, the throbbing of the pulse in the cases of hypertensive vascular disease or the compulsive hallucinatory sounds of which some psychotic patients complain—and the situation of the noise, in the head in psychoneurosis, in the ear in true intrinsic tinnitus. The distinguishing feature, however, is the presence or the absence of hearing loss. Patients with intrinsic tinnitus always suffer, at the time when the tinnitus is present, from some impairment of hearing, at least subjective, so that they feel as though the ear were full or clogged, if not objective and demonstrable by audiometer. Any patient who complains of noises only, without having at any time subjective or objective hearing loss, is to be suspected, and strongly, of having a lesion outside the auditory tract as the cause of his noises.

The accompanying classification includes the major precipitating factors in the production of tinnitus in the two classes. None of the causes listed is hypothetic or second hand. I can vouch for them all

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1. E. P. Fowler (Tinnitus Aurium in the Light of Recent Research, Ann. Otol., Rhin. & Laryng. **50**:139 [March] 1941) has used the terms "vibratory" and "nonvibratory" to describe the two groups, but such a division puts patients with psychogenic tinnitus among those having true tinnitus aurium. The present classification seems to me more accurate.

except, perhaps, that of focal infection, a concept of whose validity I become more and more doubtful. Of all the others I have had instances in my own experience.

A. EXTRINSIC

I. Vibratory
  a. Vascular bruits
  b. Muscle spasms
  c. Nasopharyngeal sounds
  d. "Clicking jaw"

II. Psychogenic

B. INTRINSIC

I. Exogenous
  a. Mechanical—trauma, explosion
  b. Occupational—riveting, aviation
  c. Chemical—lead, arsenic
  d. Drug—quinine, nicotine
  e. Infection
    1. General—influenza, acute specific fevers, focal infections?
    2. Local—middle ear suppuration
  f. Occlusion of the eustachian tube

II. Endogenous
  a. Metabolic—diabetes
  b. Nutritional—avitaminosis
  c. Hormonal
  d. Allergic
  e. Blood dyscrasias
  f. Vascular
  g. Cryptogenic

Intrinsic or true tinnitus is the variety which is of particular interest to otologists. It is to this class, therefore, that attention will be directed in the rest of this paper, and in particular to that type the causative factor in which is unknown and which I have therefore labeled cryptogenic.

ORIGIN OF INTRINSIC TINNITUS

The importance of tinnitus as a symptom is twofold—it implies an active lesion, and it involves the threat of impending or increasing deafness. What has to be determined is the site of the disturbance and its nature.

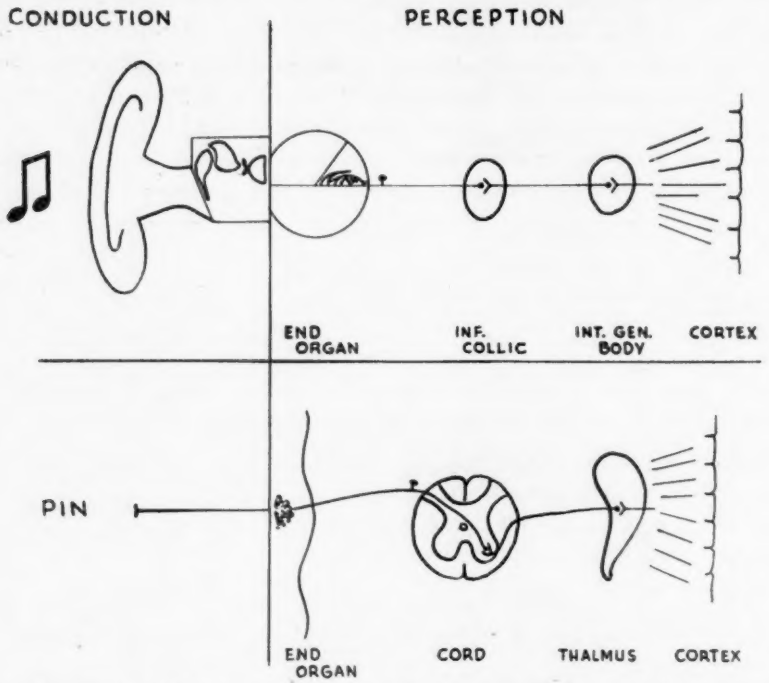
Site of the Disturbance.—In a previous paper [2] reasons have been given for believing that the disturbance which produces tinnitus is a lesion of the cochlear nerve.

Phylogenetically, the auditory tract is no other than a peripheral sensory tract modified to subserve the function of a special sense (diagram). It will therefore obey the same general physiologic rules as a peripheral nerve of common sensation and be subject to the same or equivalent disturbances of function, and for the same or equivalent reasons. Thus, a peripheral sensory nerve transmits impulses which are translated in the sensorium into sensations of touch, pain and temperature, but which in disease are distorted and are therefore translated into abnormal and unpleasant sensations of tingling, aching and burning which are called paresthesias. In the same way, the auditory nerve

2. Atkinson, M.: Tinnitus Aurium: Observations on Its Nature and Control, Ann. Otol., Rhin. & Laryng. **53**:742 (Dec.) 1944.

transmits impulses which are translated by the sensorium as normal sounds but which when distorted by a diseased nerve are recognized as abnormal and are therefore translated into disordered sound. This disordered sound is what is called tinnitus. Thus, just as a paresthesia is the expression of disease of a peripheral sensory nerve, so tinnitus is the expression of disease of the auditory nerve. It is, in fact, an auditory paresthesia, and might much better be so called, for so the fact of its neuronic origin would constantly be brought to mind.

Put in clinical terms, just as the numbness and tingling of sensory peripheral neuropathy are recognized by the patient as being endogenous



A diagram in which the auditory tract is compared with a peripheral sensory tract.

and not the result of an external stimulus applied to the end organs in the skin, so also tinnitus is recognized as being the result of some abnormal endogenous stimulus. For though the subject likens his tinnitus, for purposes of description, to sounds with which he is familiar, such as escaping steam, a peanut vendor's whistle, the hum of machinery, the roar of the sea, yet he knows that the sound he hears is only "like" these sounds, like but not the same. It is distorted sound out of tune, even a cacophony of sound, like a jumbled, jangling orchestra. It has the same unpleasant, even painful, element in it that is characteristic of sensory paresthesias. And just as with them, the patient recog-

nizes that the stimulus producing this response comes, not from without, but from within—it is endogenous, not exogenous.

In summary, then, if the argument put forward is acceptable, tinnitus may be regarded as an auditory paresthesia and as being the result of some lesion of the infrasegmental portion of the auditory tract, probably of the nerve trunk. Cochlear degeneration when it occurs (and this is by no means invariable [3]) is secondary to neuron degeneration—wallerian degeneration extending to the periphery.

Nature of the Disturbance.—It will be noted that all the causes given in the classification and accepted as valid causes of tinnitus by otologists are equally well recognized by neurologists as causes of peripheral neuropathy and its accompanying paresthesia, thus providing some further support for the theory of tinnitus as an auditory paresthesia. But what of the cryptogenic tinnitus? If one continues to think analogically, it is not unreasonable to assume that cryptogenic auditory paresthesia may be the result of the same or a similar disturbance as that which produces spontaneous peripheral paresthesia and neuropathy. The work of Leriche [4] and many others has suggested that spontaneous sensory disturbances in the limbs are the result, at least in part, of a vascular disturbance, a vasospasm. It therefore seemed appropriate to try what might be the effect on tinnitus of attempting to alter the blood supply to the part.

In the paper to which I have referred, I described some clinical experiments along these lines. All the subjects of these experiments had had troublesome and persistent tinnitus for months or years, so that lessening of the noise or even a temporary cessation could not be ascribed to the spontaneous "come and go" which is a feature of so many cases. All gave a normal response to the histamine skin test and therefore, according to my views, possessed a vasospastic mechanism.

Two contrasting types of experiments were performed. On the one hand, vasodilatation was brought about by producing a temporary block of the stellate ganglion with procaine hydrochloride or by the administration of vasodilator drugs. The opposite experiment was to produce vasoconstriction by means of vasoconstrictor drugs. The details of these experiments were given in that paper. Briefly, the results were that in a significant number of the experiments, vasodilatation produced a temporary improvement in the tinnitus while vasoconstriction produced a worsening, the latter effect being in some cases difficult to overcome. In fact, in 1 or 2 cases the effect was so severe that I said, "So

3. Crowe, S. J.; Guild, S. R., and Polvogt, L. M.: Observations on the Pathology of High-Tone Deafness, Bull. Johns Hopkins Hosp. **54**:315 (May) 1934.

4. Leriche, R.: Surgery of Pain, Baltimore, Williams & Wilkins Company, 1939.

striking and consistent has been the bad effect of vasoconstrictor drugs . . . that I have sought to avoid in patients complaining of tinnitus even the use of ephedrine nose drops."

Histamine-Sensitive Patients.—But although the great majority of patients with intrinsic tinnitus belong to the vasospastic group, once in a while, as in cases of Ménière's syndrome but much less frequently, one comes across a patient who gives an abnormal response to histamine injected intradermally. The number of such patients with deafness and tinnitus only, uncomplicated by vertigo, is small—I have record of 3 only—but the response to appropriate treatment is just as satisfactory. The importance of recognizing them lies in the fact that if they are treated with vasodilators they are made worse just as are the patients with Ménière's syndrome who belong to this group.

TABLE 1.—*Results of the Treatment of Tinnitus Aurium with Nicotinic Acid, 1940-1943*

Clinical Condition	Total Number of Cases	Number with Tinnitus	Results		
			Relief	Improvement	No Change
Deafness of middle ear type only..	64	47 (73%)	10 (21%)	30 (64%)	7 (15%)
			40 = 85%		
Deafness of nerve type only.....	33	22 (67%)	3 (14%)	12 (55%)	7 (31%)
			15 = 69%		
Total (deafness only).....	97	69 (71%)	13 (19%)	42 (61%)	14 (20%)
			55 = 80%		
Deafness and vertigo (Ménière's syndrome).....	106	106 (100%)	13 (12%)	42 (40%)	51 (48%)
			55 = 52%		
Total, including cases in which Ménière's syndrome was present.....	203	175 (86%)	26 (15%)	84 (48%)	65 (27%)
			110 = 63%		

THE TREATMENT OF INTRINSIC TINNITUS

A glance at the classification will show over what a wide field of medicine one may have to range in searching for the cause, but when it has been found, the treatment is self evident. There remains the group whose tinnitus is cryptogenic.

Vasospastic Group.—The tinnitus which results from vasospasm responds well to vasodilators, of which the most generally satisfactory, in my experience, is nicotinic acid. It is administered along the lines which I described for Ménière's syndrome.[5] The results of treatment of this sort in a group of 175 patients, 106 of them having Ménière's syndrome, and all of them complaining of tinnitus, are shown in table 1. Of these 175, 26 were completely relieved of their noises; in 84 the

5. Atkinson, M.: Ménière's Syndrome: Results of Treatment with Nicotinic Acid in the Vasoconstrictor Group, Arch. Otolaryng. **40**:101 (Aug.) 1944.

noises were so greatly reduced that only occasionally did the patients notice them, a total of 110, or 63 per cent; 65 (37 per cent) received no benefit. Of the 69 patients complaining of deafness and tinnitus alone, only 14 (20 per cent) still had their tinnitus, the remaining 55, or 80 per cent, being relieved or their tinnitus markedly reduced. It will be seen that there is a marked improvement in results when the more severe disturbance is left out of consideration.

Histamine-Sensitive Group.—This group, though small, is, as I have said, important not only academically but practically. Those patients who give a positive response to the histamine skin test respond well to treatment by histamine desensitization, just as well as the vasospastic group responds to nicotinic acid. But they respond disastrously to vasodilators just as the vasospastic group does to vasoconstrictors. It is for this reason that it is important to recognize these patients. I have a series of 31 patients who fall into this group. Of these, 28 have

TABLE 2.—*Results of the Treatment of Tinnitus Aurium (Vasodilator Group) by Histamine Desensitization*

	Cases	Results		
		Relief	Improvement	No Change
Ménière's syndrome	28	7	10	11
Deafness and tinnitus	3	1	2	
Total	31	8	12	11

Ménière's syndrome. It would seem that in this primary vasodilator group the disturbance is more apt to affect the eighth nerve as a whole, the vestibular as well as the cochlear division, and this may be because the end-organ, the labyrinth, is directly involved. Of these 31 patients, 8 have been relieved and 12 have had their tinnitus markdly reduced, while in 11 the tinnitus remains unchanged—so that 20 of 31 (64.5 per cent) have experienced marked improvement in their noises (table 2). Of the 3 patients without vertigo, 2 have been relieved and 1 has been markedly improved.

FACTORS WHICH MILITATE AGAINST SUCCESSFUL TREATMENT

1. *The cause is not always easy to discover.* For instance, in cases in which tinnitus is due to allergy the discovery of the offending allergen or allergens can be as difficult in this condition as in any other. The effect of its removal, however, can be just as dramatic. A patient of mine is sensitive to dust, feathers and wool. Feathers and dust we have been able to eliminate or desensitize to, with considerable improvement. But wool is difficult—it cannot be eliminated in winter, and

patients respond poorly to desensitization. It has been tried in this case, with no great measure of success. The result is that while in the summer she is in the main free of tinnitus and her hearing is also in the main satisfactory, when winter comes and she is forced to wear wool, her tinnitus returns. And the result of repeated insult is that year by year her hearing goes down slightly and there seems nothing for it but to go and live without wool on a South Sea island.

Chronic focal infection also, while not quite in the same class, is apt to take up much time in searching, and the surgical approach by trial and error may lead to a much depleted purse and considerable disappointment. My doubts about its validity I have already mentioned. I have yet to see a convincing case of eighth nerve neuritis due to a focal infection.

2. *The cause is not easy to remove.* For instance, if the tinnitus is occupational, it may be easy enough to say what the cause of the tinnitus is, but it may be far less easy to remove it. Cure at the cost of livelihood may appear too expensive. Similarly, diabetic neuropathies are notoriously difficult to handle, and the case cited is an instance of great difficulty in an allergic case.

In treating the vasospastic group, one great difficulty is that there is available at present no entirely satisfactory vasodilator drug. Either the effect is transient (amyl nitrite, acetylcholine), or the action is on the smaller arteries rather than on arterioles (the nitrites), or the drug is too toxic to be safe (the thiocyanates). Nicotinic acid avoids the last two difficulties, but its effect is short-lived. In consequence one has to rely, in treatment, on frequently repeated administration over long periods in the hope of overcoming eventually the disordered mechanism.

3. *The damage is already done.* Even if the cause has been discovered and can be removed, irretrievable damage may already have been done. This applies to all causes, but with particular force to vasospasm. In the first place, the vessel walls may have been damaged as the result of prolonged vasospasm so that they respond poorly to vasodilator drugs, and once what effect can be obtained has passed they return to their previously contracted state. The spasm cannot be permanently overcome. Moreover, nerve structures are very susceptible to lack of oxygen. Complete anoxemia destroys nerve function finally and completely in a matter of minutes, while partial anoxemia, even of mild degree, if often enough repeated or sufficiently prolonged, will cause irreparable damage after a time.

If the thesis is accepted that vasospasm is the cause of spontaneous tinnitus in a large proportion of the cases, then the importance of establishing adequate treatment at the first opportunity becomes apparent. Indeed, it becomes the duty of otologists to educate the rest of the profession and the public in the significance of tinnitus as a symptom

and to emphasize the importance of prompt and adequate treatment in order to forestall the onset of deafness. Hearing can often be preserved, but it can seldom be restored.

COMMENT

If the theory of a vascular disturbance, in most cases a vasospasm, as the cause of cryptogenic tinnitus is accepted, it explains many of the puzzling clinical features.

1. *The mode of onset.* In most cases this is gradual. That is to say, there will be a period of low-pitched tinnitus, more or less short, followed by an interval of freedom, more or less prolonged. As time goes on, the period of tinnitus becomes longer and the intervals become shorter until, after a variable interval of time, the noises become continuous.

But there is another mode of onset—the abrupt. In these cases there arises suddenly and without warning loud and distressing tinnitus, which persists. This is accompanied by deafness of considerable severity; or, if it arises in the course of already existing deafness, the hearing becomes suddenly much worse and may even be abolished.

The first variety suggests a recurring vascular spasm of mild degree and short duration, producing at first a disturbance of function which is no more than temporary and from which the nerve rapidly recovers. In the course of time, however, as the result of repeated insult, there results permanent damage which, as the insults continue, gradually increases. The second variety, on the other hand, suggests a disturbance of sudden nature and severe degree, a spasm so severe and so prolonged that the injury is final, permanent and irretrievable.

2. *Variation in pitch and intensity.* This can also be explained by variation in the degree of the vascular disturbance. In cases of mild disorder the noises are soft and of low pitch, but they may change suddenly and without apparent reason to a sound of much louder intensity and a much higher pitch. A low hum may be changed to, or have superimposed on it, a sudden high shrill whistle. Intensity and pitch seem to be an accurate index of the severity of the disturbance, for if treatment is successful, a gradual diminution in both of these becomes apparent. Some patients complain bitterly of sudden loud explosions in the ear, so sudden and unexpected as to make them jump. It is possible that this sudden disturbance of function is the result of an abrupt but momentary interference with blood supply. However this may be, "explosions" usually disappear promptly under treatment directed toward abolishing vasospasm, and other manifestations subside under treatment in the reverse order in which they arose. Whistle ceases, leaving only a buzz, which in its turn may cease entirely or become intermittent instead of constant.

3. *Inflation of the eustachian tube.* It follows, if the argument is accepted, that the conventional treatment of inflating the eustachian tube must go by the board except in those cases, few in number, in which a definite occlusion can be shown. It has long been apparent to critical and unprejudiced observers, patients and others, that inflation of the eustachian tube seldom results in more than temporary improvement if even that. Its use has become a habit, mainly because of ignorance as to cause. Otologists have, in the past, attempted to rationalize the procedure by findings of obstructed or narrowed eustachian tubes—findings which as often as not were the result of faulty instrumentation rather than of organic change—and of retracted drums, which are in fact no more than steeply sloped. They have tended to interpret normal variations as abnormalities in order to bolster a basically faulty concept. No doubt the present concept is not the whole truth either, but judged by the test of therapeutic response it promises better than the older one.

SUMMARY

A classification of causes of tinnitus has been suggested.

Evidence has been put forward for regarding true intrinsic tinnitus as a paresthesia of the auditory nerve.

Attention has been directed to the group of patients whose tinnitus is cryptogenic, and experiments have been described which support the theory of a vascular origin.

The results obtained in the treatment of this group by working on this theory of a vascular mechanism have been given.

The importance of tinnitus as evidence of an active lesion and a warning of impending deafness has been stressed, and the consequent urgency of instituting appropriate treatment at the earliest possible moment is emphasized.

The irrationality of inflation of the eustachian tube as a method of treatment for tinnitus has been discussed.

310 Lexington Avenue.

MANAGEMENT OF SEPTAL DEFORMITIES IN RHINOPLASTIC CORRECTION

LESTER W. EISENSTODT, M.D.
NEWARK, N. J.

WHEN one contemplates the correction of a nasal deformity, one is concerned with both the function and the external appearance of the nose. Function and appearance are intimately related, and a correction of one is not performed without serious consideration of the other. In medicine one is frequently called on to sacrifice appearance in order to improve function. The converse is seldom done. Proetz [1] vividly stated that "the patient's measure of a successful treatment—and it should be the physician's—is a nose that works, a nose of which he is not conscious." It is the purpose of this paper to discuss the management of septal deformities in conjunction with rhinoplasty.

ANESTHESIA

A local anesthetic is always the anesthetic of choice. A preliminary packing saturated with 2 per cent, 5 per cent or 10 per cent cocaine hydrochloride insures adequate topical anesthesia. In addition, a solution of procaine hydrochloride containing epinephrine hydrochloride is injected under the entire mucoperichondrium on both sides of the septum. In several hundred cases a 1 per cent solution of procaine hydrochloride with epinephrine hydrochloride 1 : 50,000 was employed. The anesthetic effect of this procedure was excellent. However, a mild amount of oozing occasionally occurred, which was annoying. In the last few hundred cases a 2 per cent solution of procaine hydrochloride with epinephrine hydrochloride 1 : 20,000 was substituted, and bleeding rarely took place. Except for an occasional temporary headache, nausea or vomiting, no untoward reaction resulted. A preliminary sedation of 3 grains (0.19 Gm.) pentobarbital sodium and ¼ grain (16 mg.) of morphine sulfate is adequate to counterbalance any toxic reaction which may occur. By infiltrating the whole of the septum with the anesthetic solution, one insures complete anesthesia and hemostasis. In addition this procedure balloons out the mucosa, diminishes the tendency toward buttonholing and makes dissection easier.

1. Proetz, A. W.: On Planning Nasal Surgery, Arch. Otolaryng. **37**:502 (April) 1943.

NASAL FUNCTION

Proetz's [2] experiments have shown that "the stream of inspired air does not pursue a straight course from nostril to choana but passes, in the main, in a wide curve beginning at the nostril, extending through the olfactory fissure and ending in the upper part of the choana, thus practically avoiding the inferior meatus entirely, except for small eddies, . . ." Examination of almost any adult nose will reveal septal deflections, crests, ridges or spurs. These may or may not be obstructive and may not alter the external appearance of the nose. If by some trauma, the septal cartilage or the nasal bones are displaced or fractured, an external deformity may result if the fracture is not reduced. The nasal septum can be bent, cracked, dislocated or pushed inwardly and will heal in its deformed position. The vomer is rarely displaced but is often thick and irregular with multiple exostoses.

The anterior free end of the septum is commonly displaced and may project into one of the nostrils. Occasionally it is split longitudinally in half and may project into both nostrils. Frequently it has an acute angulation obstructing both nasal chambers; one at the angle of deflection and one at the anterior free end. It is often dislocated from the vomerine groove. The septum may remain straight though off the midline or may curve acutely. In many instances the floor and the bridge of the septum are straight but the body is quite irregular. Any acute septal angulation is possible; exostosis and ecchondrosis are common.

The problem of nasal ventilation is a complex one. Every rhinologist has examined severely broken noses with absolutely no breathing space. Yet no subjective functional complaints are elicited from the patient. The converse is also true in some cases. The nasal chambers appear more than adequate; yet the patient complains bitterly of insufficient nasal aeration.

INDICATIONS FOR SEPTAL RESECTION WITH RHINOPLASTY

In a typical rhinoplasty one performs a bilateral osteotomy, fracturing the lateral walls of the nose medially. The upper lateral cartilages are detached from the septum and sag inwardly. The tip of the nose is narrowed. With these procedures there is a diminution of the spaciousness of the nasal chambers. Deflections, exostoses or ecchondroses which previous to rhinoplasty were symptomless might become obstructive after the plastic alterations. One compensates for the loss of space by resecting the nasal septum even though prior to operation there were no respiratory complaints. If the olfactory cleft tends to be wide, a submucous resection is unnecessary. If atrophic rhinitis is present, a septal resection is contraindicated. Should one perform a submucous

2. Proetz, A. W.: Some Intimate Studies of Nasal Function: Their Bearing on Diagnosis and Treatment, Ann. Otol., Rhin. & Laryng. **41**:125, 1932.

resection and rhinoplasty in cases of mild or moderate vasomotor rhinitis, marked improvement and even cures may be anticipated in most cases. In severe allergic rhinitis, with little or no breathing space, any operation which would further narrow the nasal chambers is not feasible. A submucous resection without plastic procedure is helpful.

Submucous resections, either partial or thorough, are indicated in about 80 per cent of nasal plastic procedures. Some surgeons prefer to do the septal correction several weeks prior to, or after, the rhinoplasty. In the majority of cases it is most advantageously performed at the same time. Some perform the septal resection before starting the plastic operation; others, at the termination of the operation, after completing the plastic procedure. I believe the latter is preferable for the following reasons:

1. The exposure is better since the columella is separated from the anterior free end of the septum and the bones of the nose are loose.
2. After reduction of the profile and shortening of the nose one is able to see exactly how much septum remains and to resect it accordingly.
3. The submucous resection is more safely performed after the pressure maneuvers necessary in a rhinoplastic procedure have been completed.

TECHNIC

At the completion of the rhinoplasty all blood clots are removed from the nasal chambers and the procaine-epinephrine solution described on page 2 is injected into the mucoperichondrium on both sides of the entire septum. A Yankauer incision is most advantageously employed, which is started about ¼ inch (6.5 mm.) posterior to the anterior free end of the septum. Occasionally, one does not shorten a nose sufficiently, and enough cartilage should be allowed to remain should a secondary shortening be necessary. The incision extends from about ¼ inch below the dorsum of the septum (which is freely visible) down to the floor. The flaps are elevated, and the septum is resected. The question often repeated by residents is, "How much septum should one remove?" If one performs a submucous resection alone, practically the whole of the quadrangular cartilage, with the exception of a generous amount of the dorsum and the anterior free end, is excised together with the perpendicular plate of the ethmoid bone and the vomer. If a nose is long (fig. 1), prominent or humped (figs. 2 and 3), one should remember that a rhinoplasty may be desired at a future date, and an appropriate amount of septum should be left.

Fig. 1.—A, preoperative photograph—elongated nose, with a mild dorsal hump and a drooping tip. If a septal resection is performed without a plastic procedure, a substantial amount of the anterior free end should be allowed to remain, since rhinoplasty may be desired at a future date.

B, photograph taken after combined submucous resection and rhinoplasty.

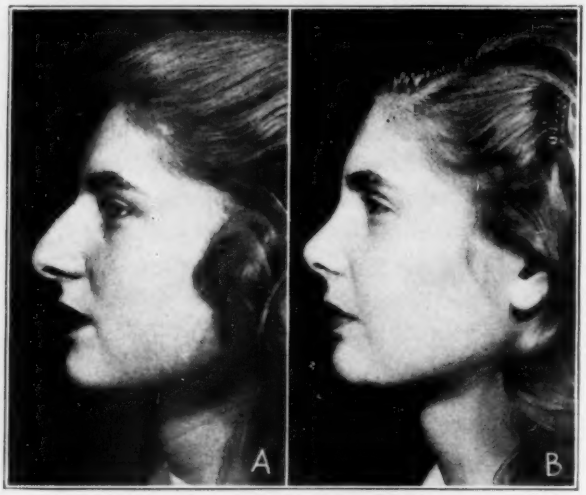


Fig. 2.—*A*, preoperative photograph—prominent humped nose. If a septal resection is performed without a plastic procedure, a substantial amount of septum is allowed to remain near the dorsum, since rhinoplasty may be desired at a future date.

B, photograph taken after combined submucous resection and rhinoplasty.

In performing a septal resection after rhinoplasty, one exercises caution in removing the septum near the dorsum. Only a sharp biting instrument like the Jansen-Middleton punch forceps is used. Cracking

Fig. 3.—*A* and *B*, preoperative and postoperative photographs of a patient who had the same complaint and underwent the same type of correction as the patient shown in figure 2.

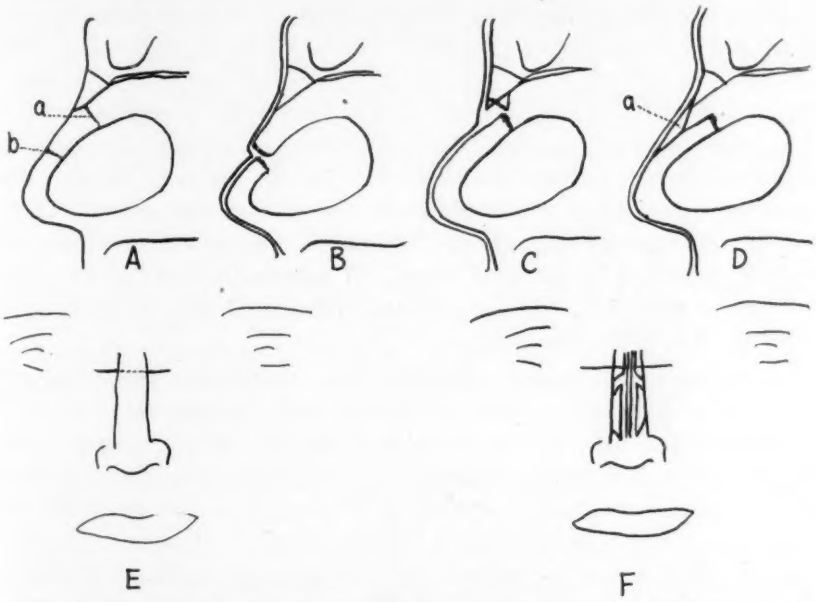


Fig. 4.—*A*, area of the septum which may be safely removed. Common sites for operative septal fractures are indicated at *a* and *b*.

B, fracture at line *a* in *A* resulting in high saddle deformity.

C, fracture at line *b* in *A* resulting in low saddle deformity.

D, correction of saddle deformity by cartilage graft (*a*).

E and *F*, straight needle passed through the skin and the top of the septum. The needle is supported by the nasal bones or the frontal processes of the maxilla.

or ripping is never done in this area. The septum is detached from the columella, the upper lateral cartilages and the nasal bones. It remains supported by its anterior free end and its attachment to the cranial floor. Careless, unnecessary trauma when one is operating near the dorsum can result in accidents in two major places (fig. 4 *A*). A fracture of the septum at line *a* in figure 4 *A* (illustrated in fig. 4 *B*) will cause a falling in of the two margins of the dorsal septum, and a low saddle deformity will result. Should this occur, three possible methods of correction are available: 1. The mucous membrane may be elevated from one or both sides of the septum at the site of fracture on the dorsum of the septum. The two ends are pushed up into apposition and sutured together. A petrolatum-impregnated gauze pack is carefully inserted into each nostril to help maintain the septum in place. 2. The two upper lateral cartilages may be sutured together over the dorsum of the septum to eliminate the depression. 3. One or several small pieces of the resected septal cartilage or bone may be instilled on the dorsum to fill in the saddle (fig. 4 *D*).

A fracture of the dorsal septum at line *b* in figure 4 *A* (illustrated in fig. 4 *C*) will result in the posterior end of the septum falling in between the two nasal bones. A higher saddle defect will result. This condition may be corrected by employing one or several pieces of the resected septal cartilage (fig. 4 *D*) or bone to fill in the depression. An admirable method of correcting this accident is performed by Zimany [3] (fig. 4 *E* and *F*). He grasps the septum inside the nose and pushes it up into its normal position between the two nasal bones. A straight needle is passed through the skin and the top of the septum (the quadrangular cartilage or the perpendicular plate of the ethmoid bone) and out through the skin again. The needle supports the septum and is itself supported by the nasal bones. It remains in situ for one week and is then removed. After seven days, sufficient union has occurred to maintain the septum in position.

Experiments on nasal ventilation have shown the importance of removing a sufficient amount of septum near the dorsum. Laszlo [4] pointed out that many operators neglect to do this. In performing a submucous resection following a nasal plastic procedure, one proceeds with great caution in this area. Owing to the peril of a possible caving in, a generous amount of cartilage is left for support. However, the floor and the remainder of the septum are thoroughly dealt with. Experience has shown that although a high deflecting area may be left out of necessity, no breathing difficulty will ensue if the floor of the septum is

3. Zimany, A.: Personal communication to the author.

4. Laszlo, A. F.: Practical Points on Submucous Septum Resection: Pitfalls and Corrections. Laryngoscope **46**:840. 1936.

thoroughly removed. It appears that the respiratory currents may follow a low curve along the lower part of the septum if the upper part of the passages are obstructed. No complaints about breathing have been encountered.

Beginners often ask about the advisability of suturing the initial submucous resection incision. If a septal resection alone is performed, it makes little difference whether or not the incision is sutured so long as the flap is held in place by a petrolatum-impregnated gauze pack. It is always advisable to suture the submucous incision when a septal resection is to be done in conjunction with a plastic procedure. There is a raw surface at the initial intercartilaginous rhinoplastic incision between the upper and lower lateral cartilages. In many cases this

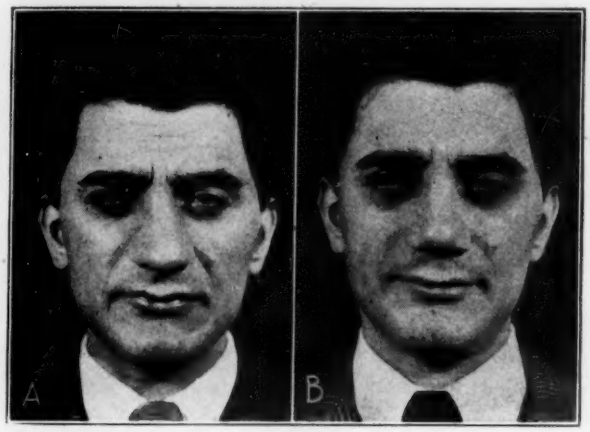


Fig. 5.—*A*, preoperative photograph—straight nose but deflected to the left. *B*, photograph taken after rhinoplasty and submucous resection.

incision and the septal incision are in apposition. An adhesion has a tendency to form between the two. If the submucous incision is sutured, and petrolatum-impregnated gauze is instilled between the two, the tendency toward formation of an adhesion is greatly diminished.

THE SCOLIOTIC NOSE

The twisted nose is the most difficult nasal deformity to rectify. The correction of it taxes the ingenuity and the skill of the rhinoplastic surgeon. One must be familiar with every possible means of correction and plan the operation accordingly. The following suggestions may serve as an aid in planning the operation.

1. The simple or mildly deflected nose. A nose which is slightly deflected may require only a routine rhinoplasty and a submucous resection to replace it in the midline and correct the impairment of breathing (fig. 5).

If the anterior free end of the septum is dislocated into a nostril, this may be corrected by excising the redundant portion if the nose is long. If the cartilage is needed for the support of the tip and cannot be sacrificed, the septum may be straightened by a complete excision and replacement (Peer [5]), a dorsoventral partial excision at the angle of deflection (Seltzer [6]) or a dorsoventral partial excision combined with an additional bisecting horizontal incision (Berson [7]).

A septum bifid at its anterior free end may be corrected by excising the entire bifid portion if the nose is long. If the entire free end cannot be sacrificed, one of the redundant wings may be excised, or one wing may be excised and the other replaced in the midline.

Fig. 6.—*A*, preoperative photograph showing the nasal bones and septum moderately deflected. The deflection was corrected by a double saw cut on the wide side, a single saw cut on the narrow side, excision of a wedge of cartilage from the septum at the angle of deflection and complete incision of the cartilaginous floor. The nose was then repositioned in the midline.
B, photograph taken after rhinoplasty.

A tip mildly deflected because of an acute angulation of the anterior end of the septum may be easily corrected in some cases by completely freeing it from the septum. It is then placed in the midline, splinted with adhesive tape and resutured to the septum with a few loose septum-columella sutures.

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5. Peer, L. A.: An Operation to Repair Lateral Displacement of the Lower Border of the Septal Cartilage, Arch. Otolaryng. **25**:475 (April) 1937.

6. Seltzer, A. P.: The Nasal Septum: Plastic Repair of the Deviated Septum Associated with a Deflected Tip, Arch. Otolaryng. **40**:433 (Dec.) 1944.

7. Berson, M. J.: The Relation of Septal Deflections to Rhinoplasty, M. Rec. **158**:734, 1945.

2. The moderately deflected nose. To maintain a deflected septal cartilage in a new position, one must either destroy its resiliency or support it with a buttress until it has healed. The cartilage has a tendency to return to its former position of displacement. Cross hatching or incision at the angle of the deflection can destroy its elasticity.

A nose which is straight but not in the midline may be centered by making a double or triple saw cut or taking a wedge of bone out of the

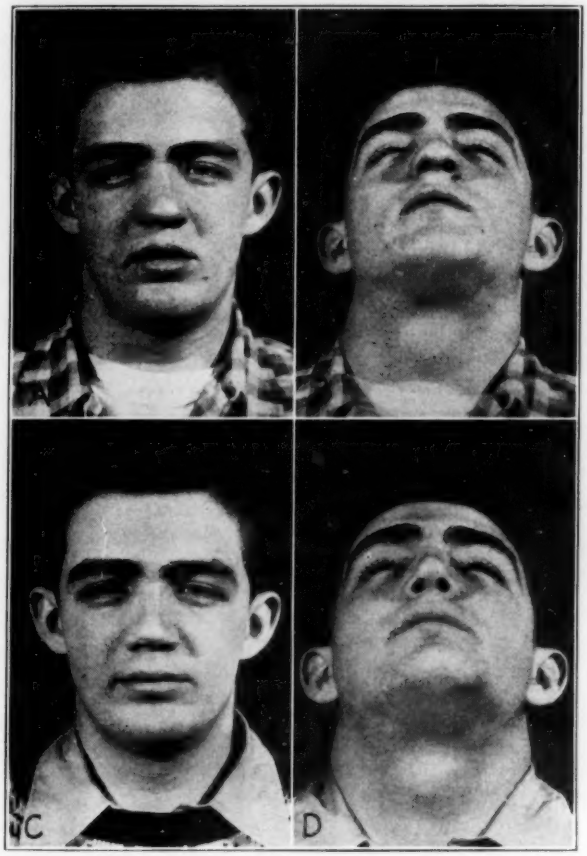

Fig. 7.—*A* and *B*, preoperative photographs—bulbous twisted nose. *C* and *D*, photographs taken after rhinoplasty.

broad side and sawing through the narrow side. The septum is completely freed from its attachment to the vomer by cutting through the cartilage and both mucoperichondrial flaps with a Bard-Parker knife or turbinotome. It is now freely movable and may be swung into any desired position. The septum may be pushed over to the opposite side of the vomer and will sink in slightly, overriding the vomer. No necrosis

or septal perforation results from this maneuver. A septal resection may then be performed if deemed necessary. It is essential, however, to leave the vomerine spurs as a buttress to prevent the septum from swinging back into its position of deformity, since the resiliency of the cartilage is not broken.

The nose moderately deflected because of an acute angulation of the lower or the middle third of the septal cartilage (figs. 6 and 7) is best corrected by excising a thin wedge of cartilage at the angle of deflection from the roof to the floor and incising the floor (Seltzer [6]). If a septal resection is deemed necessary, it should not be performed at this time but at a later date.

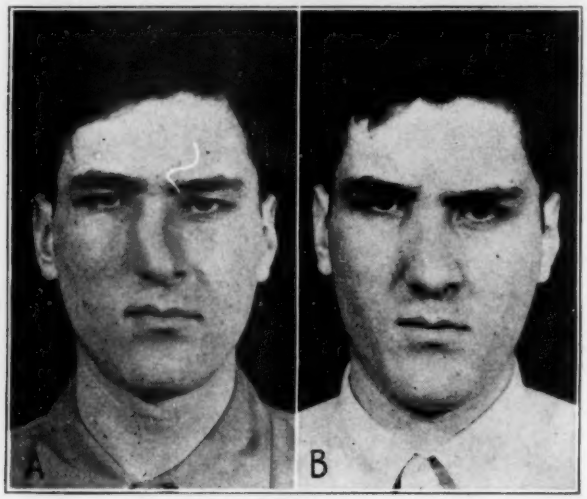

Fig. 8.—*A*, preoperative photograph—nose severely fractured and dislocated to the right. The dislocation was corrected by triple saw cuts on the wide side, a single saw cut on the narrow side, disarticulation of the septum from the nasofrontal angle and complete incision of the cartilaginous floor. The nose was then repositioned in the midline.
B, photograph taken after rhinoplasty.

3. The severely fractured nose. To correct this type of deformity, one or more of the procedures advocated in the foregoing paragraphs is employed.

Occasionally, the nasal bones are dislocated at the nasofrontal angle (fig. 8). After separating the nasal bones by fracturing them outwardly (Aufricht [8]), one must free the septum from its attachment to the nasofrontal angle. A wide chisel is inserted, and its edge is firmly placed against the frontal bone. With the body of the chisel as a lever, the

8. Aufricht, G.: A Few Hints and Surgical Details in Rhinoplasty, Laryngoscope **53**:317. 1943.

septum is cracked at the nasofrontal articulation. The nasal bones may then be repositioned in the midline. Needless to say, in this case it is unsafe to perform a submucous resection together with the plastic procedure. If necessary, the resection may be performed at a later date. A mere straightening of the septum, without resection, however,

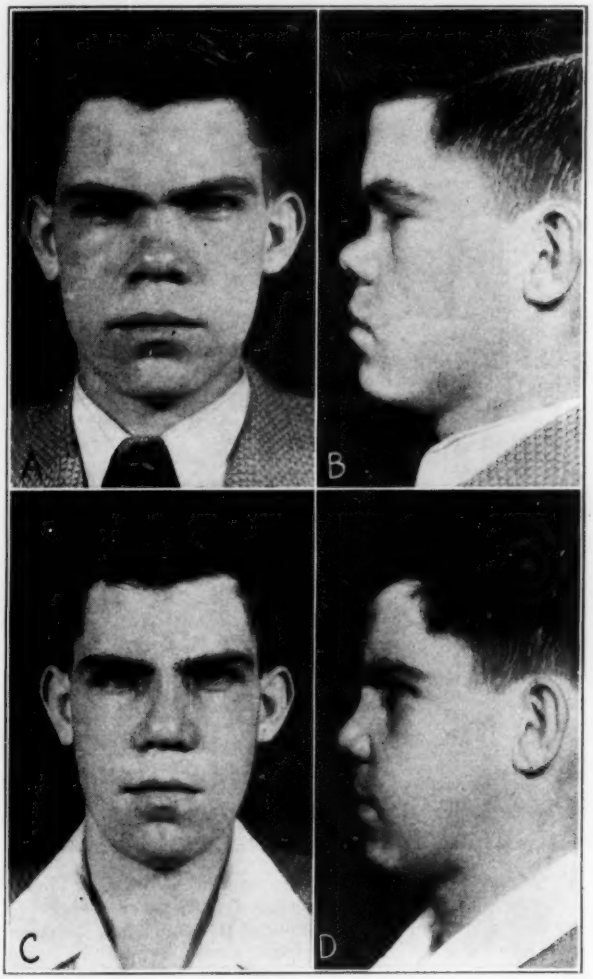

Fig. 9.—*A* and *B*, preoperative photographs—post-traumatic deflected saddle nose.

C and *D*, photographs taken after alining the fragments and implanting preserved cartilage into the dorsum.

markedly improves ventilation, and a septal resection may not be necessary.

The deflected saddle nose (fig. 9) is corrected by freeing the fragments and alining them in the best possible manner. A straight piece

of preserved or autogenous cartilage may be modeled and instilled over the dorsum of the nose, and a straight nose will result. In these cases the septum is unusually thick, double or triple, and a thorough septal resection must be performed.

Postoperative septal infections are rare. Simple hematomas may be left undisturbed and treated conservatively. They are usually absorbed in three to four weeks. Evacuation of the blood clot needs be performed only if the hematoma is marked or a secondary infection is feared.

Fig. 10.—*A, B* and *C,* nasal deformity present at birth. This Negro baby boy was 6 weeks old. The Wassermann test showed parents and child free from syphilis. There was a normal simple delivery at term. No instrument or anesthetic was employed. The mother fell down a whole flight of stairs one week before term and delivery. There is a question whether the infant shows a congenital or a prenatal post-traumatic deformity.

SUMMARY AND CONCLUSIONS

The managing of septal deformities in conjunction with a rhinoplasty has been discussed. A submucous resection, either partial or complete, is advocated for about 80 per cent of cases in which a nasal plastic procedure is done.

A submucous resection and rhinoplasty offer marked improvement and even cures in cases of mild or moderate vasomotor rhinitis.

It is easier and more economical to perform a submucous resection in conjunction with a rhinoplasty than to do each at separate operations.

If a caving in of the dorsal septum results from undue traumatism, it should be immediately corrected by suturing the fractured ends together, suturing the upper lateral cartilages together over the dorsum of the septum, instilling a piece or pieces of resected cartilage or bone into the dorsum, or by "pinning" the septum in place.

It is always advisable to suture the submucous incision to prevent adhesions when a septal resection is performed in conjunction with a rhinoplasty.

31 Lincoln Park.

SUPERIOR PETROSAL AND CAVERNOUS SINUS THROMBOSIS AND BASAL PETROSITIS

Observed as Complication of Destructive Labyrinthitis With Facial Paralysis

FRANCIS L. WEILLE, M.D.
BOSTON

THE following history describes one of the most interesting otologic cases I have ever encountered at the Massachusetts Eye and Ear Infirmary during nearly two decades of service. The facts presented may provide objective experience for other otologists faced with similar difficult decisions.

The hospitalization period can be divided into four parts: (*a*) management of paralysis of the left side of the face complicating an acute exacerbation of chronic suppurative otitis media on the left side with mastoiditis and destructive labyrinthitis; (*b*) management of superior petrosal and cavernous sinus thrombophlebitis and supracochlear basal petrositis complicating the destructive labyrinthitis; (*c*) management of meningitis complicating conditions in *b*, and (*d*) convalescence.

In time, the first period approximated three weeks, the second about six weeks and the third and fourth about twelve weeks.

REPORT OF A CASE

On Oct. 22, 1943 a 12 year old white Brazilian boy was admitted to the Massachusetts Eye and Ear Infirmary, complaining of a draining left ear and paralysis of the left side of the face.

He gave a history of having had a discharging left ear for two years, with periods when the draining had seemed to stop. He had had "summer grip" a month before coming to the hospital. A week after the grip started, his left ear "began to discharge" and he became drowsy. A week later he noticed that he was unable to move the left side of his face and that he could not whistle.

About four days before admission he suffered from nausea, vomiting and vertigo with indefinite headache. Two days later he had chills and fever, with "progressive stiffness of the neck." He felt "quite ill" when he entered the hospital.

The temperature was 99.8 F., pulse rate 88 and respiratory rate 20. The left ear was draining purulent discharge from a large marginal perforation in the anterior quadrants of the drum, through which a large mass of granulation tissue protruded as a polyp. Sagging of the wall of the posterior superior canal was present. There were no postaural signs. With masking of the normal right ear, complete nerve deafness of the left ear was demonstrated. There was complete peripheral paralysis on the left side of the face. The remainder of the neurologic examination was noncontributory, including examination of the fundi and findings at lumbar puncture. Results of the fistula test were negative. There was no

From the Otolaryngological Service of the Massachusetts Eye and Ear Infirmary.

spontaneous nystagmus. Past pointing of the right hand was absent; the left hand past pointed 3 inches (7.6 cm.) to the left.

Results of the general physical examination were normal. A culture from the aural discharge was reported as containing "coagulase-positive hemolytic Staphylococcus aureus, nonhemolytic streptococcus, gram-positive bacillus of the colon group and Bacillus subtilis" (table 1).

TABLE 1.—*Bacteriologic Reports*

Date	Ear	Blood	Eye	Cerebrospinal Fluid	Smear for Tuberculosis
10/22	1. Coagulase-positive hemolytic Staph. aureus 2. Nonhemolytic streptococcus 3. Gram-negative colon bacilli; all groups 4. B. subtilis (Planted only aerobically)	No growth	.....	No growth (2 specimens)	
10/24	Mastoid; no growth (Planted only aerobically)				
11/16	.....	.....	.....	No growth	
11/28	.....	.....	.....	No growth	
11/29	Left vestibule; no growth	No growth			
12/ 2	Inoculations of guinea pig for tuberculosis of the left ear; pig 163 died; negative reaction; pig 164 died too early for diagnosis				
12/ 7	.....	No growth	.....	.....	No acid-fast bacilli found
12/15	.....	No growth			
12/25	.....	.....	Left eye: B. proteus		
1/12	.....	.....	.....	Beta hemolytic streptococcus, group A; virulent (2 specimens: a. m. and p.m.)	
1/13	.....	.....	.....	Beta hemolytic streptococcus, group A; virulent; another specimen yielded no growth	
1/14	.....	.....	.....	No growth (2 specimens: a.m. and p.m.)	
1/15	.....	.....	.....	Beta hemolytic streptococcus isolated from cerebrospinal fluid is sensitive to penicillin (4 plus)	
1/15, 16, 17, 18, 19, 20, 22, 23 and 28; 3/17	.....	.....	.....	No growth	

The white blood cell count was 5,600, red blood cell count 4,200,000 and hemoglobin content 80 per cent; a smear showed 67 per cent polymorphonuclears.

Observations in roentgenograms of the mastoid were reported (table 2) by Dr. A. S. Macmillan: "Both mastoids were underdeveloped. The right mastoid was small and clear. The left mastoid was sclerosed. Destruction was present in the cochlear region and lateral area of the semicircular canal." It is to be emphasized that these roentgenograms made certain before operation that there was destruction of a portion of the lateral labyrinthine capsular wall.

TABLE 2.—*Summary of Roentgenograms*

Area	10/22	11/15	11/17	11/27	12/6	12/14	1/8	1/11	1/14
Sinuses	.....	Normal; large adenoid	.....	Normal	.....	Right antrum slightly thickened; rest clear	.....	Left ethmoid slightly thickened; adenoid mass	
Mastoids and petrous pyramids	Both mastoids underdeveloped; right mastoid small and clear; left mastoid sclerosed; destruction of the cochlear region and area of the lateral semicircular canal	.....	Defect in roof of petrous bone beyond arcuate eminence; postoperative removal of some of bony capsule	More destruction in region of labyrinth; opening beyond area of semicircular canal remains the same	No further involvement of petrous bone	Right mastoid small and normal; no further change in petrous bone	.....	.....	Right mastoid small and relatively clear; left mastoid postoperatively: all cells removed; petrous bone normal
Skull	.....	.....	.....	Normal					
Teeth	.....	.....	.....	Upper left first molar abscessed	.....	.....	Upper left first molar root abscessed; upper right first molar root abscessed		
Chest	.....	.....	.....	.....	.....	Clear			
Left orbit	.....	.....	.....	.....	.....	Normal			

A radical mastoidectomy on the left side was done immediately by the postaural route. The mastoid was found to be sclerosed, but a large area of destruction, occupied by a mass of granulations, was found in the region of the mastoid antrum. The anterior half of the horizontal semicircular canal had been destroyed together with the upper vertical portion of the fallopian canal in the mastoid. The promontory was gone; the mass of granulations, which extended through the drum into the canal filled the middle ear and extended into the cochlea, vestibule and horizontal canal. The facial nerve was embedded in the same mass, which was trimmed as much as possible without endangering the nerve. A small area of normal dura in the middle fossa was exposed; the lateral sinus was also exposed but appeared to be normal.

A flap was cut from the canal wall and placed over the lower portion of the facial ridge and bowl. The wound was left widely open, without suturing, after sulfanilamide powder had been applied to the cavity. Care was taken in using iodoform gauze to keep the wound edges apart, not to make pressure on the area of exposed facial nerve.

Inasmuch as nature had performed the equivalent of a labyrinthectomy on this patient, it was decided not to do further labyrinthine operation at this time. More-

TABLE 3.—*Reports on Pathology*

Date	Area	Diagnosis	Gross Findings
10/23	Mastoid	Chronic inflammation	One small piece of tissue (in Zenker's solution) measuring 3 mm.
12/ 2	Left ear	Fibrinopurulent exudate	A 2 mm. piece of tissue (in Zenker's solution)
1/15	Middle ear	Chronic inflammation	Several small fragments of tissue (in Zenker's solution) measuring 1 cm.
1/15	Stapes; petrous bone	Chronic inflammation	Piece of tissue (in Zenker's solution) measuring 0.2 cm. Fragment of bone (in Zenker's solution) measuring 0.2 cm.

over, it seemed reasonable to expect that simple decompression of the exposed facial nerve might restore its function. The complete removal of the granulation tissue described entailed (*a*) sacrifice of the facial nerve or (*b*) exposure of the facial nerve in the fallopian canal remaining, with stripping of the nerve trunk of the granulations if the nerve was to be preserved. It was decided to trim away as much of the inflammatory tissue as possible to decompress but not endanger the nerve. Because of complications, the operation in *b* had to be done later.

A biopsy specimen of the granulation tissue (table 3) was reported as showing "chronic inflammation."

The postoperative convalescence during the next three weeks was entirely uneventful. Sulfadiazine therapy (chart 1) was omitted after a total intake of 51 Gm. in twelve days. At a physical therapy consultation regarding the facial paralysis three days postoperatively, it was stated: "The patient has partial reactions of degeneration. There is a trace of response to a tetanizing current and some voluntary function." A week later the same department reported "no reaction of degeneration and improvement in function. Response to tetanic current was not so lively on the left as on the right side. There was a good prognosis."

On November 11, nineteen days after operation, it was noted that "the facial function had returned completely."

The cavity was clean and healing well. The wound was still kept widely open to assure maximum drainage and freedom from any pressure. The patient

was up and around the ward. The temperature, pulse and respiration charts showed normal figures.

Twenty-two days after operation (November 14) a temperature of 99.2 F. was observed, with slight swelling of the left upper lid as the only abnormal physical finding. Roentgenograms of the sinuses (table 2) were reported as showing a "large adenoid and normal sinuses." The swelling disappeared within a day or two. The patient was not ill; the slight fever subsided. Three days after the swollen upper lid had first been seen, roentgenograms of the mastoid (table 2) were reported as showing "a defective roof of the petrous pyramid beyond the arcuate eminence. There was postoperative removal of some of the bony capsule." A week after the orbital swelling had disappeared, it began to come back.

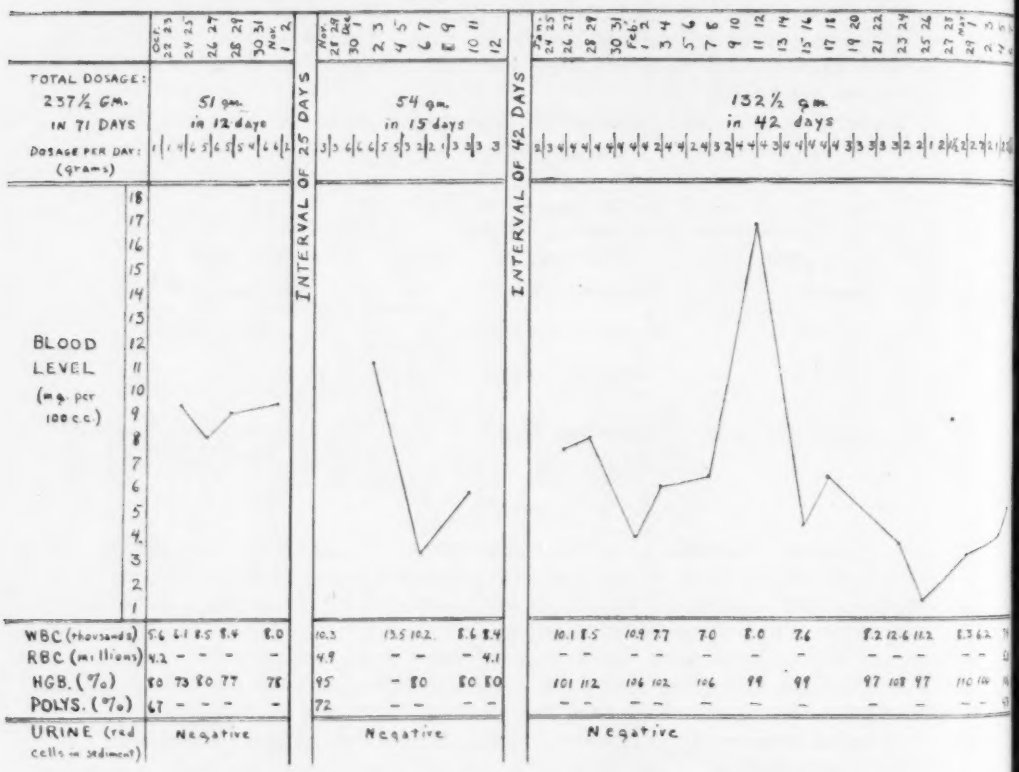

Chart 1.—Sulfadiazine dosage, blood level, blood counts and urine.

On Nov. 28, 1943 the following statements at consultation with physicians in the eye service were put in by the aural resident physician, Dr. Lewis: "This boy has had chronic suppurative otitis media on the left side, with labyrinthitis and facial paralysis. Radical mastoidectomy was done on the left side five weeks ago, with recovery of the facial nerve, a clean wound and no intracranial complications. For the past twenty-four hours he has had a slight exophthalmos on the left side. Dr. Weille stated the belief that there may be involvement of the superior petrosal sinus. He would like examination of the (1) fundus, (2) visual fields and (3) extraocular muscles and (4) opinion as to the degree of proptosis."

The reply by Dr. Paul Chandler was: "The right fundus is normal. The left disk shows some blurring of the upper and nasal margin, with a suggestion of increased capillarity on the disk. There is no real swelling, and this appearance could be normal. Since it is apparently unchanged from Nov. 27, 1943, it probably is normal. Exophthalmos is to be measured." The exophthalmometer measurements were: "right eye 16 and left eye 22." The vision and visual fields were normal.

Cochlear and vestibular tests were done with great care. The conclusion was that "cochlear and vestibular function in the left ear was not present."

Further roentgenologic studies (table 2) were made. The sinuses and skull were normal. The upper left first molar was abscessed. The mastoids and petrous pyramids were reported as having "more destruction in the region of the labyrinth. The opening beyond the area of the semicircular canal remained the same."

A lumbar puncture showed an initial pressure of 160 mm., with normal dynamics, and 2 cells. The total protein content was 34 mg. per hundred cubic centimeters. The fluid was sterile. A culture of the blood was sterile (table 1). The neurologic examination was noncontributory.

Exploration of the left labyrinth was advised and carried out by Dr. Meltzer and Dr. Weille on Nov. 29, 1943, with the patient under ether anesthesia. The radical cavity of the previous operation was freed of granulation tissue except in the area of exposed facial nerve. The entire remnant of the horizontal semicircular canal was excised together with the superior canal except for the common crus. The vestibule was entered posteriorly, so that a probe easily passed from behind into the vestibule, the cochlea and the middle ear. As discovered at the first operation, the promontory, cochlea and vestibule had been destroyed by disease, nature having done a partial labyrinthectomy. A probe could be passed from an area of destruction in the region of the petrosal course of the facial nerve backward and upward to the area of destruction in the petrous bone beyond the arcuate eminence. It was decided not to excise the granulation tissue in which the facial nerve was known to lie exposed and not to excise the posterior semicircular canal or to explore the petrous pyramid further at this time. A single drop of pus was found in the vestibule; it was cultured and later found to be sterile. Granulation tissue was found throughout the exploration, but no other pus.

Sulfanilamide powder was placed in the operative field, and the wound was left open.

Recovery from the operation was uneventful. During the following week the temperature was never above 99.6 F. or pulse rate above 96 or respiratory rate above 20. However, the exophthalmos became worse.

One week after the operation the following note was written in the record: "The proptosis has definitely progressed during the past few days. In addition, there is more immobility, especially in lateral and upward gaze. There is some questionable chemosis of the palpebral conjunctiva, and, for the first time, there is some discomfort behind the eye. This is most likely a circulatory disturbance, but the question is, where is the block? It does not seem as if thrombosis of the superior petrosal sinus alone would cause this much proptosis. Compression of the jugular vein on lumbar puncture does not suggest involvement of the lateral sinus. The fifth, ninth, tenth and eleventh cranial nerves seem normal, and there is no tenderness of the jugular vein."

Physicians in the eye and neuromedical services (Paul A. Chandler, Chief of the Eye Service) replied to consultations the next day as follows:

A. "The right eye is normal. The left eye shows considerable limitation of motion in all directions. Some edema of the lid and slight blush to the upper lid are

present. The conjunctival vessels are somewhat dilated, especially in the upper fornix. The optic disk shows definitely papilledema of 1 to 2 diopters, with edema extending out into the macula. In the absence of more evidence of orbital cellulitis and especially in view of the papilledema, venous thrombosis seems the most likely explanation of this acute condition."

B. "The neurologic examination showed (1) unilateral proptosis (of the left eye); (2) paralysis of the upward, downward, inward and outward gaze of the left eye; (3) diplopia; (4) papilledema of the left side (2 diopters), and (5) central scotoma on the left side. The vision is good in the right eye and also in the

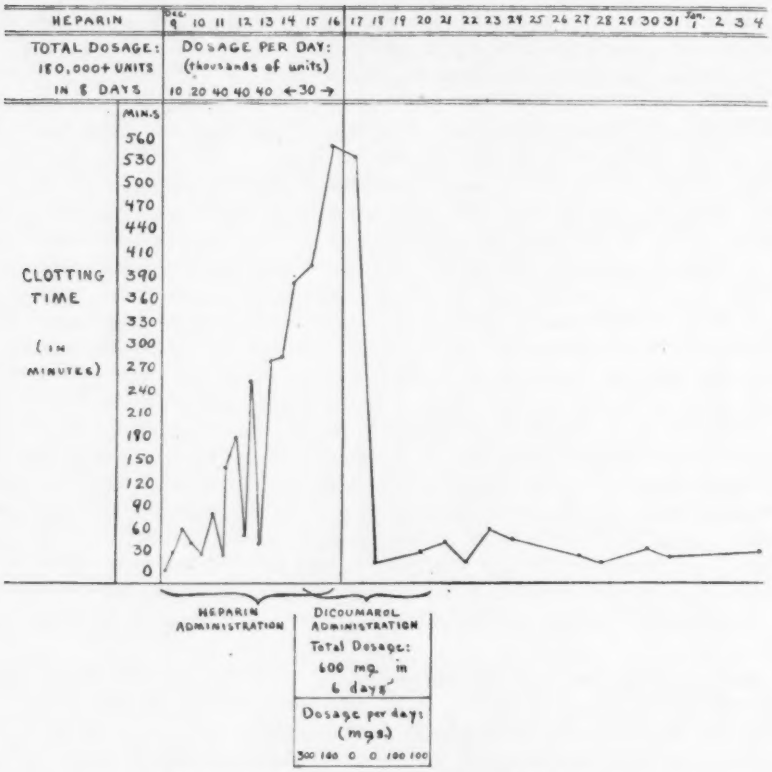

Chart 2.—Heparin dosage and clotting time.

left (except for a 'dark spot' in the center of the field). There are at present no weakness on the left side of the face, no rigidity of the neck, no paralysis in the extremities and no signs in the pyramidal tract; the grips are good. There is no disturbance to pin, touch, vibration or position. The diagnosis appears to be cavernous sinus thrombosis."

Heparin therapy was instituted, on the hypothesis that the pathologic process was a sterile (or almost sterile) thrombophlebitis which had extended from the left labyrinth or from the region medial to the left arcuate eminence into the left superior petrosal sinus and retrogradely into the left cavernous sinus. It was hoped that such treatment would prevent further progression, especially into the right cavernous sinus.

Chart 2 summarizes the period of heparin dosage and the resulting changes in clotting time. It was found difficult to control the day and night intravenous drip of heparin and, even under the most ideal conditions, to keep a uniform clotting time of about two hours. It was finally decided to utilize dicumarol (3,3′-methylene-bis-[4-hydroxycoumarin]), since this drug accomplishes the same purpose as heparin in preventing intravascular clotting and could be given by mouth. It was, furthermore, a simpler task to measure the prothrombin time in seconds by which the dosage and effectiveness of the drug were gaged than to determine the hours of clotting time daily. However, with heparin therapy the clotting time could be easily restored to normal by the use of menadione bisulfite (vitamin K). With dicumarol any further surgical intervention offered a distinct risk[1] of serious hemorrhage for perhaps two weeks after effective treatment had ceased. It was felt that this risk was obviated[2] somewhat by having vitamin K oxide available in the ward for instant use in case a surgical emergency arose or in case spontaneous hemorrhage occurred. Transfusion could be easily done also.

In spite of such treatment (chart 3) and in spite of the patient's temperature remaining either normal or a fraction of a degree from normal, with the exception of a single elevation to 101 F. on the sixth day of heparin therapy, the condition of the orbit steadily worsened. Severe chemosis of the conjunctiva developed in the left eye as the proptosis became extreme. It was felt that the left eye would be lost, and the right eye, which remained normal throughout, was watched with some anxiety.

The medical service could "not offer another diagnosis or suggest changes in treatment."

Because a sterile thrombosis of the cavernous sinus is rare and orbital malignant growth even in young persons not uncommon, physicians in the tumor service were asked to see the patient. The reply on December 23 was: "Since the consensus seems to favor a left-sided cavernous sinus thrombosis, we do not think that external irradiation will offer any benefit to this patient. If a tumor is found on a biopsy specimen, we shall be glad to see him again and undertake treatment."

On Christmas Day, five and one-half weeks after the first orbital swelling had been observed, there was spontaneous drainage of pus from the inner aspect of the left conjunctival sac at its superior angle—apparently from the superior ophthalmic venous system. A culture yielded Bacillus proteus.

Immediate improvement occurred, and the improvement continued during the succeeding week. Dicumarol therapy was stopped two days after the conjunctival purulent drainage occurred.

On New Year's Day it was reported by the eye service that "there was still exophthalmia present, with limitation of the movements of the left eye, especially in upward gaze. The disk margins were clear at that time. The vessels appeared more normal, and no vitreous opacities were noted. . . . The site of the spontaneous rupture appeared sealed off with some free pus beneath the tissue." Incision and drainage of this pus was advocated by the eye consultant but was rejected because of the patient's improvement and the degree of risk involved.

Two and a half months after admission I was asked to show the patient at a staff meeting as a patient with cured cavernous sinus thrombosis. This request was

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1. Walker, J., and Rhoads, J. E.: Effect of Dicoumarol on Susceptibility to Action of Heparin, Surgery **15**:859 (May) 1944.

2. Wheeler, E.: Personal communication to the author.

deferred for a week. During that time meningitis developed. On Jan. 11, 1944, the temperature rose to 102 F. and stiffness of the neck developed. Lumbar puncture revealed a cloudy spinal fluid with an initial pressure of 350 mm. The cell count was 2,350, with 89 per cent polymorphonuclears. The total protein content was 138 mg. per hundred cubic centimeters, the sugar content 34 mg. and the chloride level 646 mg. Culture of the spinal fluid showed beta hemolytic streptococcus.

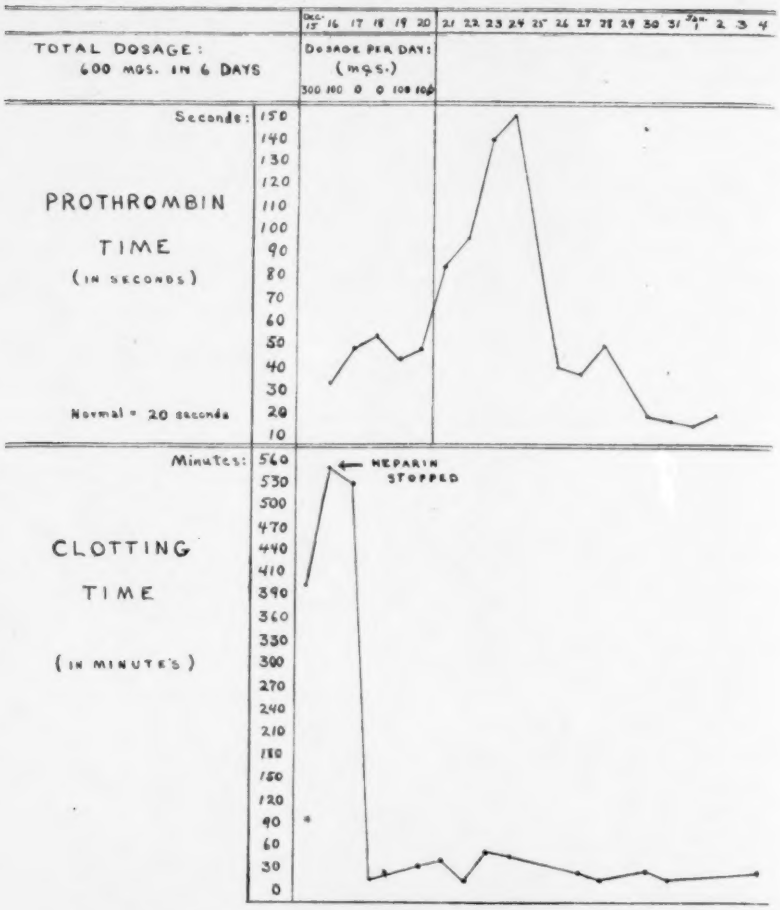

Chart 3.—Dicumarol dosage, prothrombin time and clotting time.

Administration of penicillin intramuscularly and intrathecally was started. Chart 4 shows the total dosage. It was administered intramuscularly every three hours and intrathecally twice daily. Chart 4 also summarizes the responses of spinal fluid to this treatment (plus operation; see following paragraphs).

The neuromedical service found "no definite neurologic signs of localizing value" for possible abscess of the brain."

It was debated by the otolaryngologic service as to whether the meningitis originated from the orbit, residual inflammation of the cavernous sinus, a brain

abscess or the left petrous pyramid and associated labyrinthine thrombophlebitis. It was decided to explore and excise what remained of the left labyrinth together with portions of the petrous pyramid until healthy bone was everywhere encountered. This was done on Jan. 15, 1944, eighty-five days after admission.

At this operation the posterior perilabyrinth was explored. The posterior semicircular canal and the remnant of the superior canal were excised. The posterior perilabyrinthine bone was removed to and above the internal auditory

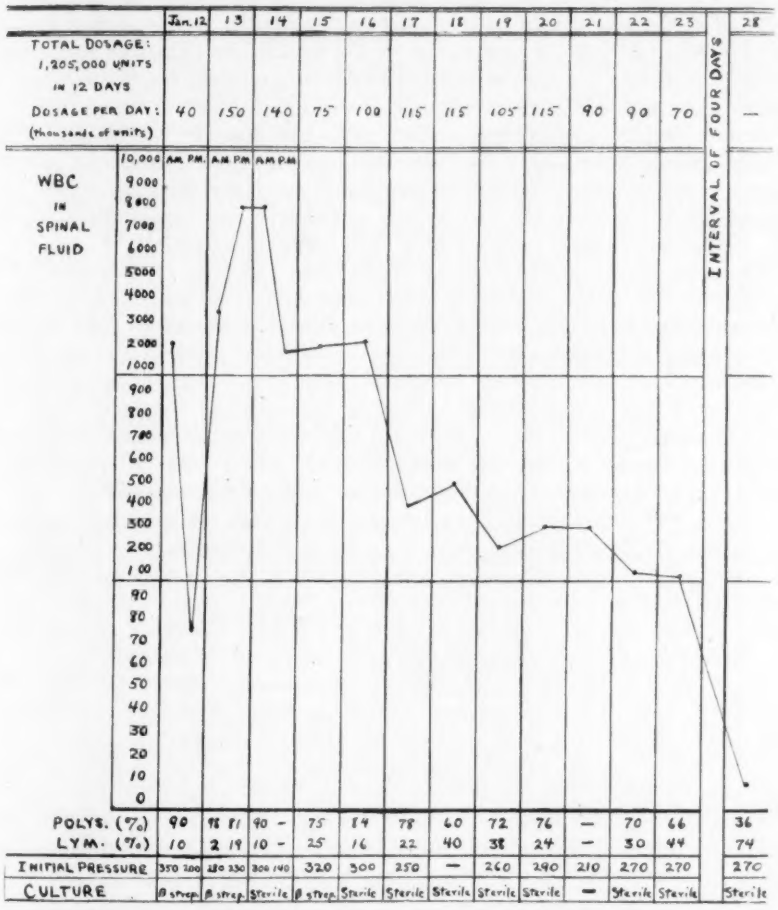

Chart 4.—Penicillin dosage and spinal fluid findings.

meatus. The upper portion of the uneroded part of the facial canal within the mastoid was dissected, dental instruments being used to take the bone away from the facial nerve. When healthy nerve was encountered, it was followed superiorly and stripped of all granulation tissue in the portion previously found exposed by disease. This dissection was carried to the petrosal (geniculate) portion of the nerve. The nerve trunk was found to be a helpful anatomic guide in certain remaining portions of the operation.

The middle fossa dura, the sigmoid sinus and the cerebellar dura were widely exposed; Citelli's angle was removed in its medial portion, and the superior petrosal sinus was widely exposed from below.

Granulations of the middle ear were removed together with those lying within the cochlea; a portion of the modiolus and the anterior wall of the cochlea were excised.

The anterior wall of the bony external auditory canal was removed below the petrotympanic fissure, together with the posterior root of the zygoma.

Then the carotid artery was exposed in its relation to the eustachian tube and utilized as a guide in exploration of the anterior perilabyrinth and petrous pyramid; here only a moderate amount of bone was removed before hard, normal osseous tissue was encountered.

A wide endaural incision for securing wide-open drainage through the concha was done, a rubber dam was placed over the facial nerve, sulfanilamide powder was applied to the wound, a single iodoform wick to keep the postaural wound open was applied and no suturing of any kind was done. The wound was left open. The patient was in good condition at the end of the operation.

The penicillin was omitted after 1,205,000 units had been given over a twelve day period. The cell count of the spinal fluid dropped to 78 cells in six hours after the intrathecal administration of the penicillin but was above 3,000 cells the next morning and above 8,000 cells a few hours later. After the operation and continued use of penicillin both intrathecally and intramuscularly, the cell count of the spinal fluid dropped within a week to approximately 100 cells. Five days later the count was 11 cells. After the administration of penicillin had been stopped, sulfadiazine therapy was again instituted. Chart 1 summarizes the sulfadiazine therapy as administered throughout the patient's hospitalization.

The further convalescence was entirely uneventful. The wound gradually healed. Results of the general physical examination became entirely normal.

On March 16, 1944 the patient was presented at the "grand rounds" of the neurologic service. At this presentation the following note was made in the record: "The original diagnosis of cavernous sinus thrombosis was not questioned, in view of recovery after rupture of the . . . abscess" through the conjunctival sac. On March 22, 1944 an eye consultant found the "eyes white and quiet. The muscular rotations were full. There was slight ptosis of the upper lid of the left eye. Disk margins were clear. There was no edema."

The patient was discharged home on March 25, 1944, five months and three days after admission. On April 26 he was seen as an outpatient. The following note was made in the record: "The left ear is dry. The cavity is well epithelized. The wound is firmly healed. The patient is in excellent condition. Facial motions appear to be normal. Body weight today is 98 pounds (44.5 Kg.); weight on admission was 90 pounds (40.8 Kg.)."

COMMENT

Interesting and instructive points for comment are (1) the facial paralysis and labyrinthitis, (2) the thrombophlebitis, (3) the petrositis and (4) the chemotherapy.

1. *Facial Paralysis.*—Facial paralysis was the patient's chief complaint on admission. It was treated successfully throughout the patient's illness but at a great cost in the management. Relief of pressure on the widely exposed labyrinthine capsular and upper mastoidal portions

of the nerve trunk by radical mastoidectomy permitted recovery of the nerve. However, because the exposed trunk was embedded in a mass of granulations, it was assumed at the first and second operations that the nerve must be sacrificed if the granulations were excised. This made for a less thorough "labyrinthectomy," condoned because (*a*) the cochlea and vestibule and about half of the horizontal canal were found to have been destroyed by disease at the first operation; (*b*) it was assumed then that this, nature's own operation, provided adequate "drainage" and that the granulations were merely a reparative process; (*c*) even at the second operation additional work on the labyrinthine capsule was carried out, with the tacit assumption that excision of all granulation tissue was synonymous with cutting of the nerve and that no useful purpose would be served by so doing, and (*d*) it was only the onset of meningitis which forced the decision to pay little further attention to facial function. However, in retrospect, if the third operation (about four hours long) had been done instead of and at the time of the second, the meningitis might have occurred just the same, and it would have been felt that it resulted from too drastic surgical procedures.

It is doubtful that this operation would have interrupted the course of the already established thrombophlebitis.

When, finally, an exceedingly thorough labyrinthectomy was done, the operator decided (*a*) that he had been deceived by the three weeks of apparently uneventful convalescence following the first operation and (*b*) that, in the presence of visible grossly destructive labyrinthitis, it would have been better, despite the risk to the facial nerve in this case, to have carried out a Uffenorde type of labyrinthectomy about two weeks after the first operation. This might have prevented the later stormy course, but if such a course had occurred anyway one would have been convinced that it was a result of operation! If the convalescence had been uneventful, the labyrinthectomy would have seemed, in retrospect, unnecessary and dangerous surgical treatment. This case is therefore of particular value in medical experience.

It is not difficult deliberately to expose the facial nerve technically, but there are no instruments in the routine mastoid kit which serve this purpose readily (even 0000 curets). Flat dental double-ended excavators are admirably suitable for lifting the bone away from the nerve. Aside from a detailed anatomic knowledge of the position of the normal nerve, it is of vital importance not to crush bone in against the nerve trunk.

In this case, the facial nerve having been dissected out a few millimeters below the area of the trunk exposed by disease, it was easily possible to strip away the granulations retrogradely onward to the region of the geniculate ganglion. The nerve then served as a perfect

anatomic landmark for the thorough labyrinthectomy which was done. Further, good exposure of the anterior region of the cochlea was helpful in exposing the carotid artery, which was used as a guide in the petrous exploration.

It is to be noted that cochlear labyrinthine fistulas are supposed to be rare. Not only was the anterior portion of the lateral canal found destroyed by disease, but a large portion of the promontory was gone also. A biopsy specimen of the granulation tissue showed no evidence of tuberculosis, nor did test guinea pigs reveal this disease.

2. *Thrombophlebitis.*—Thrombophlebitis was dramatic, to say the least. The leads to this diagnosis were (*a*) the labyrinthitis (a focus from which thrombotic venous involvement could occur); (*b*) the fact that two of the three important labyrinthine veins drain into the superior and inferior petrosal sinuses respectively and that there was roentgenologic evidence of destruction of bone medial to the superior semicircular canal near the superior petrosal sinus; (*c*) evidence of orbital venous obstruction, with unilateral orbital swelling otherwise unexplained (as by sinusitis, e. g.); (*d*) venous engorgement and then the choked disk, of the left eye, watched while developing; (*e*) unilateral proptosis gradually followed by fixation of the globe, dilated pupil and chemosis, (*f*) final rupture of pus (yielding B. proteus) from the medial superior fornix of the conjunctival sac, apparently from the ophthalmic vein. (Since nature utilized a vein for drainage of the cavernous sinus in this case, it would seem to offer consideration of using such a pathway surgically in cavernous sinus thrombophlebitis by means of an orbital incision to expose the superior ophthalmic vein.)

Against the diagnosis was the absence of signs of obvious infection of the blood stream—chills, picket fence temperature and organisms in culture of the blood.

Attempts to control the thrombophlebitis by the use of heparin were partially successful in that the right eye did not become involved. However, this remedy was difficult for the patient in that it had to be given intravenously day and night; at night, when the patient slept, the needle would at times become misplaced. Heparin is said to lose its action within twenty minutes to two hours after cessation of dosage. It was effective in prolonging clotting time up to nine hours in this case when given continuously. Schall [3] expressed the opinion that about one and one-half hours are ideal for a therapeutic clotting time in cavernous sinus thrombosis.

The shift to dicumarol was for convenience, ease of the patient and equal therapeutic effect. The drawback was that this drug is said,[1] because of risk of hemorrhage, to contraindicate any operation for about

3. Schall, L. A.: Cavernous Sinus Thrombophlebitis, Mississippi Doctor **19**:398 (May) 1942.

two weeks from the time of its cessation. It was felt by Wheeler,[2] our consultant who administered the drug, that in a real emergency vitamin K oxide would control the prothrombin time adequately (as would transfusion temporarily).

In this case, it should be emphasized that it was just as difficult to control the prothrombin time (chart 3) with dicumarol as the clotting time with heparin. The prothrombin time, normally twenty seconds and ideally fifty to sixty seconds for this patient, actually reached one hundred and fifty seconds at one time, four days after the administration of dicumarol had been stopped. The total dose of dicumarol was 600 mg., distributed over six days.

Clotting times are not usually determined along with prothrombin times but were studied by us in this case and remained at about thirty minutes for a long time.

3. *Petrositis.*—With the extensive destruction of the labyrinthine capsule, demonstrated by roentgenologic examination preliminary to the first operation, together with a "dead labyrinth" on functional tests surgical attention was focused on the facial paralysis and the destructive labyrinthitis at the first operation.

At the time of the first orbital swelling, there was roentgenologic evidence (on November 17) of a "defect in the roof of the petrous bone beyond the arcuate eminence" (table 2). This had not been present when the patient was admitted to the hospital. Ten days later this area was reported to "remain the same."

At the second operation (November 29), supracochlear basal petrosal destruction was demonstrated and a probe could be passed posterosuperiorly from the region of the geniculate ganglion anteromedial to the superior semicircular canal. This area contained the same type of granulation tissue found in the labyrinth itself and appeared to be a simple direct extension of the middle ear and labyrinthine pathologic changes.

It was assumed at this time that the labyrinth itself—not the small area of basal supracochlear petrositis—required major attention. A single drop of pus was found in the region of the vestibule; only granulations were encountered elsewhere, including the fistula into the anterior perilabyrinth.

At the third operation, not only were the remnants of the labyrinth excised, but dissection of the petrous pyramid was carried out until healthy bone was encountered in all directions. Thus, the posterior perilabyrinthine bone was removed, including Citelli's angle (which nominally extends from the knee of the sinus and sinodural angle to the region of the superior canal), and also the bone beyond this, underlying the superior petrosal sinus to just beyond the internal auditory meatus. The internal auditory canal itself was not disturbed.

The removal of the anterior buttress, in addition to the foregoing sections, and wide exposure of the middle fossa dura over both the mastoid and the middle ear (but without wide excision of the squama) was the equivalent of a modified Eagleton operation, while the exposure of the ascending portion of the carotid artery, with removal of the bone between it and the cochlea, simulated Ramadier's technic. The operator followed the horizontal portion of the carotid as a guide to excise the basal portion of the anterior perilabyrinth. Since within a few millimeters there appeared healthy bone, it was not necessary to carry out Lempert's apicectomy technic.

An interesting sidelight of the three operations was the use of a postaural incision and special canal flaps, which assured the maximum need for exposure with minimum sacrifice of skin. In the third operation these procedures allowed either endaural or postaural exposure, permitting the surgeon a choice.

4. *Chemotherapy.*—The use of heparin and dicumarol has already been discussed. The most interesting comment regarding the use of the sulfadiazine (chart 1) is that in this 12 year old boy, weighing 90 pounds on admission, 237.5 Gm. of sulfadiazine was administered in a total of sixty-nine plus days' treatment divided into three periods: the first lasted twelve days, in which 51 Gm. of the drug were given; in the second period, 54 Gm. were given in fifteen days, and in the third period, 132.5 Gm. were given in forty-two days. There were periods of twenty-five and forty-two days respectively separating the second from the first and third periods of administration. It is a striking fact that the white cell count was 7,400, the red cell count 5,000,000 and the hemoglobin content 106 per cent at the time the sulfadiazine was finally discontinued and that at no time were there any red cells found in the urinary sediment. It has been commonly observed that reactions to sulfonamide therapy frequently occur after about ten days of administration at adequate blood levels. There was no hesitation in this case to keep the blood level (table 3) high enough for adequate treatment, depending on the patient's condition. Yet, there was never any reaction to drugs.

The most striking finding in the intrathecal method of penicillin therapy for meningitis was the sharp drop in the cell count of the spinal fluid from over 2,000 cells to 78 cells within six hours of the first intrathecal injection. In spite of continuing intramuscular and intrathecal administration of penicillin, the cell count of the spinal fluid rose above 8,000 within twenty-four hours after the dramatic drop. The count remained at this level for only twelve hours and then dropped, as shown in chart 4. A total intrathecal and intramuscular dosage of 1,205,000 units was given over a period of twelve days.

247 Commonwealth Avenue.

THYROGLOSSAL CYSTS AND SINUSES

Analysis of Forty-Three Cases

LOUIS HUBERT, M.D.
NEW YORK

THIS presentation is based on a clinical analysis of 43 patients with thyroglossal cysts and sinuses that were admitted to the Manhattan Eye, Ear and Throat Hospital in a ten year period, from 1931 to 1940 inclusive. These cysts and sinuses are of interest not only because they are of embryologic origin but also because in many instances they are confused with other conditions and treated incorrectly before they are recognized. For the correct diagnosis and treatment, a working knowledge of the embryology of the thyroid gland is necessary because these cysts and sinuses are due to a congenital disturbance of the development of this gland.

NORMAL DEVELOPMENT OF THE THYROID GLAND

Early in fetal life the anlage of thyroid gland arises as an evagination in the ventral wall of the primitive pharynx, between the first and second pharyngeal pouches. In adult life this position corresponds to the foramen cecum at the base of the tongue. This primitive thyroid structure descends in the midline of the neck to its normal position through tissue which later becomes the hyoid bone, thus accounting for the intimate relationship of the two structures. In its descent the primitive thyroid structure forms a tubule, or tract, lined with epithelial cells, called the thyroglossal duct, or tract. When the primitive thyroid structure has fully descended to its usual position, the thyroglossal tract becomes obliterated.

ABNORMAL DEVELOPMENT OF THE THYROID GLAND

Occasionally the primitive thyroid structure does not descend at all but continues to develop at the base of the tongue, giving rise to a lingual thyroid. At times there occurs only a partial descent, resulting in an aberrant thyroid. In some instances the thyroglossal tract fails to become obliterated, even after the thyroid gland has fully descended and reached its normal position. In such cases cysts may develop. Any fluid secreted by the epithelial cells follows the tract made by the

Read at the meeting of the New York Academy of Medicine, Section on Otolaryngology, New York, Nov. 21, 1945.

descending thyroid gland and presents itself as a mass in the midline of the neck, anywhere from the base of the tongue to the normal position of the gland. This mass varies in size from that of a pea to that of a large egg and is far commoner below the level of the hyoid bone than above it. The skin over the cyst is normal except when exposed to infection; then inflammation and suppuration may ensue. The cyst may rupture through the skin spontaneously or may be incised by some one who does not recognize its true nature. A fistula or a sinus is thus formed. In a fistula the channel runs up to the foramen cecum, which can sometimes be demonstrated by methylene blue appearing in the mouth after its injection into the cutaneous opening. In a sinus there is a draining channel ending blindly in the tissues of the neck.

AGE INCIDENCE

Although cogenital, thyroglossal cysts may appear at all ages and in both sexes from birth until late in life (in 1 of our cases, as late as 69 years of age). However, they are more frequently seen in young persons

Age and Sex

Age, Years	Patients, No.
1 to 10	11
11 to 20	13
21 to 30	11
31 to 40	4
41 to 50	1
51 to 60	2
61 to 70	1
Sex	
Males	24
Females	19

(see the table). It seems likely that the secretion formed by the epithelial cells of the thyroglossal tract may empty into the mouth through the foramen cecum without the formation of cysts. In other words, it is possible to have a patent thyroglossal tract without signs or symptoms. When a number of years later a cyst does develop, it can be explained by the assumption that the foramen cecum has become blocked owing probably to some infection.

SYMPTOMS

Thyroglossal cysts usually produce no symptoms. The only complaint is the presence of an offensive discharge when a sinus or fistula develops. However, a large infected cyst at the base of the tongue may cause difficulty in swallowing and dyspnea, due to local inflammatory edema.

DIAGNOSIS

The diagnosis of a thyroglossal cyst situated below the hyoid bone is not difficult. It is a soft, painless, fluctuating mass, moving upward with deglutition, occupying a midline position and connected with the hyoid bone by a duct, which can often be felt on palpation. If this duct can be felt, the diagnosis is practically certain. If not, the aspirating needle furnishes a reliable means of diagnosis. If the aspirated fluid contains epithelial cells and cholesterol crystals and the mass is in the midline of the neck, one may also be certain of the nature of the cyst. In case the cyst becomes infected and suppuration sets in it will be painful to pressure and the aspirated fluid will contain a large amount of pus.

To diagnose a thyroglossal cyst located above the hyoid bone is not always easy. When the patients come to a physician, the cysts are usually infected and suppuration has set in. An infected cyst at the base of the tongue is usually mistaken for a lingual abscess. When the infected cyst is in the submental region, there is a diffuse and painful swelling and the diagnosis of a submental abscess is made. The true nature of the lesion is not recognized until after repeated incisions and drainage. Finally, the diagnosis is established by microscopic examination of the tissues removed. The wall of a thyroglossal cyst is lined with ciliated columnar or squamous epithelial cells. It is composed of fibrous connective tissue which sometimes contains small patches of lymphoid cells, which furnish a fertile soil for infection. In the capsule may also be found mucous glands and thyroid alveoli.

DIFFERENTIAL DIAGNOSIS

Thyroglossal cysts must be differentiated from suprahyoid and infrahyoid aberrant thyroid glands [1] undergoing cystic degeneration. A thyroglossal cyst at the base of the tongue should not be mistaken for a lingual thyroid. The differential diagnosis is made on the absence of thyroid tissue in its usual position in lingual and aberrant thyroids. This should always be ascertained before operation; otherwise myxedema may result. A large thyroglossal cyst located lower than usual may be mistaken for a cyst of the thyroid gland. This error can be corrected at the operating table, as happened in 1 of our cases. While a large cyst was being separated from the surrounding tissues, it was noticed that it was connected by a pedicle with the hyoid bone, that it was situated in the midline of the neck and that it had no connection with the thyroid gland. The diagnosis of a thyroglossal cyst was confirmed by the pathol-

1. The term "aberrant thyroid," as used in this paper, means a median-placed thyroid gland in the vicinity of the hyoid bone, without a thyroid proper in its usual position.

ogist. When the cyst is small, e. g., the size of a pea, the diagnosis is often missed. After removal of the little growth, a discharging sinus or fistula develops and then the true nature of the lesion is recognized. One must not forget that a thyroglossal cyst and a thyroid adenoma may be present in the same person, as occurred in 1 of our patients. In the differential diagnosis of thyroglossal cysts, one should keep in mind that all too frequently they are mistaken for abscesses and, consequently, there is a history of repeated incisions and drainage without cure.

TREATMENT

The treatment of thyroglossal cysts and sinuses is surgical and consists in the complete removal of the entire thyroglossal tract. Any operative procedure which fails to remove the entire epithelial-lined tract results in failure, i. e., recurrence of the cyst or persistence of a draining sinus or fistula. Inasmuch as the tract passes occasionally above but more frequently through or immediately below the hyoid bone, gland structures are often present under the periosteum and midportion of this bone. Therefore, in order to cure these troublesome lesions, the midportion of the hyoid bone should always be removed, even in cases in which the tract passes above the hyoid bone, because of the better exposure and facility in tracing it to the foramen cecum. Although Schlange,[2] as early as 1893, and Durham,[2] in 1894, removed a segment of hyoid bone and dissected the tract to the root of the tongue, it was Sistrunk [3] who first recognized and called attention to the fact that it was not always possible to trace the tract, because of its small size and friability, from the hyoid bone to the foramen cecum, even in cases in which methylene blue was used to visualize it. He made no attempt to isolate the tract but removed the duct and the tissues surrounding it for a distance of ⅛ inch (0.3 cm.) on all sides, coring out, as it were, the tissues between the hyoid bone and the foramen cecum in a line, which the tract almost invariably follows, drawn at an angle of 45 degrees from the upper surface of the center of the hyoid bone backward and upward toward the base of the tongue.

Operation.—A transverse incision about 2 inches (5 cm.) long is made across the neck at about the level of the hyoid bone. The skin, the subcutaneous tissue and platysma muscle are reflected. The cyst is usually found lying on the thyrohyoid membrane. Slow and careful dissection from the surrounding tissue will expose the pedicle uniting

2. Schlange and Durham, cited by Pemberton, J. DeJ., and Stalker, L. K.: Cysts, Sinuses and Fistulae of the Thyroglossal Duct, Ann. Surg. **111**:950 (June) 1940.

3. Sistrunk, W. E.: Surgical Treatment of Cysts of the Thyroglossal Tract, Ann. Surg. **71**:121 (Feb.) 1920.

it with the hyoid bone. At this point the tract passes through or below the hyoid bone, although it is occasionally found passing above it. The muscles attached to the central portion of the hyoid bone are freed above and below, and a piece of bone measuring about ¼ inch (0.6 cm.) is removed. Up to this point the dissection can be carried out with little difficulty, but, farther up, the tract may be small and friable and difficult to remove. In such a case no attempt is made to isolate the tract, but the duct and the tissues surrounding it for a distance of ⅛ inch (0.3 cm.) on all sides are cored out through the muscles of the tongue to the foramen cecum. This can be done without difficulty, as Sistrunk has shown that the pathway of the duct corresponds to a line drawn at 45 degrees backward and upward through the point of intersection of lines drawn horizontal and perpendicular to the center of the hyoid bone. In cases in which there is a definite communication with the mouth, as shown by methylene blue, the tract can be more easily followed and the foramen cecum is removed. In other cases the mouth is not entered, the dissection stopping at the foramen. It should be remerbered that at times lateral branches are found between the hyoid bone and the foramen cecum. They can be recognized by the injection of methylene blue and should, of course, be removed.

When a sinus or fistula is present, it is best to inject the methylene blue a day before the operation, in order to outline the tract. Some of the methylene blue that is spilled into the surrounding tissues during the injection will be absorbed within twenty-four hours, but the coloring matter within the tract will still remain, thus facilitating its removal. An elliptic incision is made around the sinus or fistula, and the tract is carefully dissected from the surrounding tissues and traced to the midportion of the hyoid bone, which is removed. The dissection is continued to the base of the tongue in the same manner as previously described.

CLASSIFICATION OF PATIENTS

Among 43 patients that were investigated, the thyroglossal cyst was below the hyoid bone in 25 and above the hyoid bone in the submental region in 5. In 13 patients there was a draining sinus or fistula. They are grouped together, because in some of the cases no differentiation between a sinus or fistula was made. Although some authors question the possibility of making this differentiation, I have been able to demonstrate it in a few instances. It is true that when the thyroglossal duct passes through the hyoid bone, the fistulous tract is so narrow and friable that the methylene blue cannot be forced through to appear in the mouth. In the cases in which I have been able to demonstrate a true fistula, the tract passed underneath the hyoid bone, as was shown later at the operation.

OPERATIVE RESULTS

Before Sistrunk published his system of operation in 1920, operative failures were the rule. Since then the operative results have been favorable in the hands of competent surgeons. In mentioning the number of operations performed in each case to bring about a cure, I do not count incision and drainage of an infected cyst as an operation but only as a preliminary step to the radical operation. In our series of 43 patients, there was no recurrence in 21 after one radical operation. Seventeen patients had been operated on twice; 12 had the first operation at other hospitals. Three patients were operated on three times, the first two operations having been performed at other hospitals. Two patients were operated on four times. These multiple operations should be avoided if possible, because the large amount of scarring and the resulting deformity make a satisfactory operation almost impossible. When a radical operation has been properly performed and some time later a draining sinus appears, I assume that it is due to the overlooking of a lateral branch of the thyroglossal tract. In such a case I prefer the use of the coagulating current to destroy the sinus. This procedure, which can be done in the office, is simple and practically painless, provided the surgeon does not use the full strength of the current at the start. I go over the entire sinus wall with a properly insulated applicator, using a current of low intensity. Gradually increasing the strength of the current, I go over the same area again and again. This seems to act as a local anesthetic, because the patient does not complain of pain even after the full strength of the coagulating current is applied. For obliteration of the sinus it may be necessary to repeat this procedure several times.

SUMMARY AND COMMENT

In order to facilitate the diagnosis and treatment of thyroglossal cysts and sinuses, a working knowledge of the development of the thyroid gland and of the possible anomalies is essential. The thyroglossal tract represents the course along which the thyroid gland descends from its origin at the base of the tongue to its normal position. Occasionally the thyroid does not descend, and the result is a lingual thyroid. At times the gland descends only partially, and the result is an aberrant thyroid. When the thyroid gland descends to its normal position but the thyroglossal tract remains patent, cysts, sinuses or fistulas may develop. Errors in the diagnosis of these lesions will be less frequent or possibly eliminated if every mass situated in the midline of the neck, no matter how small or how large and no matter at what age it appears, whether below or above the hyoid or at the base of the tongue, is considered a possible thyroglossal cyst. When the diagnosis has been established, the only treatment is the radical removal of the

entire thyroglossal tract. This operation should not be performed in the presence of an acute infection. If pus is suspected, it is best to make a simple incision, provide drainage and wait until the inflammation has subsided, before the radical operation is performed. If this technic is followed, recurrence is not likely. However, if a draining sinus does appear sometime after a complete and thorough operation, I prefer the use of the coagulating current, as described in this paper, to obliterate the sinus. But the use of this current as the method of treatment of thyroglossal cysts and sinuses, as advocated by some authors, is inadequate and should be condemned.

161 East Seventy-Ninth Street.

MYIASIS OF THE NOSE

CAPTAIN NICHOLAS P. POPOV
MEDICAL CORPS, ARMY OF THE UNITED STATES

WITH the rapid change in residence among members of the medical profession, particularly those in the armed forces, many clinical problems arise involving conditions which many have never had an opportunity to see. In this paper 3 cases of myiasis of the nose are reported with a discussion of the causation, symptoms, pathologic aspects and treatment.

INCIDENCE

Myiasis is any disease caused by maggots or flies. In the United States, insect invaders carry on their greatest work of destruction among cattle. Effects were never seriously felt outside of Texas until the season of 1890, at which time the insect pests were reported from several other localities.

Previous to the present century, there are only a few examples on record of myiasis of the human nose. There are a number of insects whose larvae may attack human beings. The best known are the common blow fly (Calliphora vomitoria), the saw fly (Cochliomyia [Compsomyia] macellaria)[1] and the green bottle fly (Lucilia caesar).

The insects belong to the order Diptera and the family Muscidae. The larva of the saw fly is called the Texas screwworm because of its common occurrence in the state of Texas. Saw flies (Cochliomyia [Compsomyia] macellaria) were first found in Mexico and South America by entomologists. Dr. Williston of Yale College stated that the saw fly now occurs everywhere from Canada to Patagonia. The flies are found predominantly in warm dry climates.[1] In the tropics this insect invader is not found at high elevations even though swarming at lower elevations. In Mexico it has never been found above an altitude of 4,200 feet (1,280 meters). Very few cases of myiasis have been described in Europe.[2] In 1935 it was estimated that there were over 100 cases of the disease in human beings in the southern part of the United States.[3]

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1. Goldstein, M. A.: The Texas Screw-Worm and Its Invasion of the Nasal Cavities, Laryngoscope **3**:335-340 (Dec.) 1897.

2. Robertson, C. M.: The Texas Screw Worm: Report of a Fatal Case, Laryngoscope **4**:150-155 (March) 1898.

3. Strong, R. P.: Stitt's Diagnosis, Prevention and Treatment of Tropical Diseases, ed. 6, Philadelphia, The Blakiston Company, 1942, vol. 2, pp. 1511-1515.

This disease has been observed by me in Southern California. Three patients, all male, were treated in San Diego County General Hospital during 1940 and 1941. Two patients recovered, and 1 died five hours after admission. In a series of cases compiled by Aubertin and Buxton the mortality was 8 per cent.[3]

CAUSATION

Myiasis is caused by the hatching of eggs laid within the nose by a fly. The foul odors of a chronic catarrhal inflammation, syphilitic rhinitis, atrophic rhinitis or ozena attract the fly.[4]

The eggs of the saw fly (which may be taken as an example of the general type) are described as follows: The eggs have the appearance of a dense, light yellow mass, and it is known that each fly will deposit as many as twenty thousand eggs. Goldstein, of St. Louis, reported a case in which he had removed a mass of ovae, which showed the presence of over five hundred single eggs, from the nose of a patient.[1] Twenty-four to forty-eight hours are required for the larvae to hatch, and immediately afterward their work of destruction begins.

The matured larva or maggot is three fourths of an inch (1.9 cm.) in length and about one eighth of an inch (0.32 cm.) in diameter. The body is creamy white and is made up of segments. Between each two segments is a ring of bristles. This causes the maggots to resemble a screw, and its name is derived from the resemblance.

McKenzie described the fly under the name "Lucilia hominivorax." It is 9 mm. in length, with tawny palps and a light tawny face. The cheeks are covered with golden yellow down. The head is large and wider in front. The thorax is blue, with black and yellow stripes. The abdomen is the same color. The wings are transparent, and the feet are black.[2]

The fly is attracted by a foul-smelling discharge from the nose or the ear. It needs to be in the nose only for a moment to deposit its eggs.[4]

SIGNS AND SYMPTOMS

The chief signs and symptoms observed by St. Pair and Chapuis and reported by Coquerel [5] were as follows: There was formication of the nose with severe frontal headache, accompanied, in some cases, by a sensation resembling blows with an iron bar. Swelling of the nose

4. Ballenger, W. L.: Diseases of the Nose, Throat and Ear, ed. 4, Philadelphia, Lea & Febiger, 1914, pp. 289-290. Ballenger, W. L., and Ballenger, H. C.: Diseases of the Nose, Throat and Ear, ed. 7, ibid., 1938, p. 103.

5. Coquerel, C.: Sur un nouveau cas de mort produit par le développement de larves de la Lucilia hominivorax dans le pharynx: description de la larve de ce diptère, Arch. gén. de méd. **13**:685-691, 1859.

which extended over the face and involved the eyelids especially was often met with. Epistaxis was a common finding. Often there was considerable inflammation of the internal tissues of the nose. In some cases this inflammation spread to the meninges, causing death. Occasionally tumors, which opened spontaneously, occurred in the nose, and from them large numbers of larvae escaped.

Ballenger stated that as a rule there is stenosis, usually complete, on the affected side of the nose.[4] The disease occurs mostly in flat noses. It may occur at any age and is commonest in hot weather, from July to September.

Frantzius,[6] of Costa Rica, observed that sneezing was an early and constant symptom. He attributed this to the tickling sensation caused by the gliding movement of the larvae.

I noticed, associated with the symptoms already mentioned, toxemia with considerable elevation in temperature, pulse rate and respiration rate, pain in the maxillary regions and lower jaw, and backache.

PATHOLOGIC ASPECTS

The pathologic effects of the disease consist of a more or less total destruction of the mucous membrane lining the nasal and accessory cavities of the nose. It is, in the early stages of myiasis, difficult to pick the larvae from the mucous membrane, as they seem embedded in the tissue, and the diagnosis may be difficult until the larvae appear, after which a mistake is impossible. The larvae denude the bone and cartilage, and in the later stages burrow through the thin bony plates. Whether the brain substance is softened by necrosis before or after is a question, but in cases that have resulted fatally great numbers of larvae were found in the brain substance. In many instances when the cerebral substance is infected the ventricles are found filled with bloody serum, or the meninges are found to be of a deep red color and filled with blood.

MacKenzie reported a number of cases in which the patients had died of meningitis. His cases were reported from India.[7]

TREATMENT

The treatment of this disease has been complicated by the ability of the maggots to survive in many antiseptic solutions. Experimentally it was found that a fully matured maggot could live for four minutes

6. von Frantzius, A.: Ueber das Vorkommen von Fliegenlarven in der Nasenhöhle von Tropenbewohnern, die an Ozæna leiden, Arch. f. path. Anat. **43**:98-107, 1868.

7. Foster, H.: Report of a Case of Two Hundred and Seven Screw Worms Taken from the Nose, Laryngoscope **3**:341-342 (Dec.) 1897.

in pure phenol, and for fifteen minutes in strong turpentine. The maggots can crawl for several minutes over a surface strewn to a depth of one-eighth inch with pure mild mercurous chloride U. S. P. Chloroform was proved most satisfactory, as an exposure of thirty seconds to this atomized vapor invariably kills the worm. Solution of mercury bichloride 1:1,000 or a solution of formaldehyde U. S. P. diluted 1:10,000 may be used by injection. Glymol (a petroleum derivative) was successfully used by W. Scheppegrell, of New Orleans.[8]

Syringing or washing of the nasal cavities should be avoided, because the current might carry some of the eggs higher up into the nasal spaces.

I have used a 10 per cent solution of chloroform in milk as a nasal spray and removed the maggots mechanically with forceps from the nose at several different sittings each day. By such a procedure the maggots are gradually removed from the nose. Sneezing will also dislodge great numbers of the larvae. Relief from pain and sleep should be induced when necessary.

REPORT OF CASES

CASE 1.—A white youth 20 years of age (imbecile) was admitted to the San Diego County Hospital on Sept. 15, 1940. This patient, according to his parents' statement, had suffered from chronic sinusitis for a year. On the afternoon of admission a private physician was consulted who instilled a mercury preparation in the patient's nostrils. This drove forth some twenty-four maggots which were removed by suction. The nose was then packed with iodoform gauze. On Sept. 15, 1940, the patient had a postnasal hemorrhage and was sent to the San Diego General Hospital by the private physician.

On admission the patient appeared toxic, with a fetid odor coming from the nose. His temperature was 104 F., his pulse rate 32 and his respiration rate 38. Nasal packing was removed, and chloroform sponges were applied in the nasal passages. Ten maggots were removed. A posterior nasal tampon was then put in place, and the patient was given 1,000 cc. of isotonic solution of sodium chloride by hypodermoclysis.

The patient died five hours after admission. Necropsy was not performed.

CASE 2.—A 14 year old Mexican boy, a student by occupation, was admitted to the San Diego County General Hospital on Sept. 18, 1940. The patient stated that a fly flew into his left nostril on September 15 and remained there for about ten minutes before he could remove it. Two days later the patient began to bleed from his left nostril. This continued intermittently during the day with the gradual development of a frontal headache. On the morning of September 18 he saw a private physician, who removed twenty maggots from his left nostril and sent him to the hospital. On admission the patient complained of pain over the left eye and left side of the jaw. Both nostrils were full of pus, there was edema over the left antrum and there was a foul odor coming from the nose. His temperature was 100.8 F., his pulse rate 110 and his respiration rate 24.

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8. Scheppegrell, W.: The Use of Oil for the Destruction of Larvae in the Nasal Chambers, Laryngoscope **4**:86-89 (Feb.) 1898.

With the use of chloroform spray, sixty-five maggots were removed or expelled by the patient between September 18 and 20. A roentgenologic examination of the sinuses showed a faint clouding of both antrums, more evident about the periphery and compatible with mucosal hyperplasia. The ethmoid areas also appeared clouded. The patient's temperature reached 105 F., his pulse rate 103 and his respiration rate 22 on September 20. After this date the patient's condition began improving, and his temperature, pulse rate and respiration rate became normal in four days. The patient was discharged from the hospital on September 30.

CASE 3.—A white man 51 years of age, a farmer by occupation, was admitted to the San Diego County General Hospital on June 30, 1941.

The patient gave a history of nosebleeds on various occasions during the previous few years. The patient on admission complained of backache, headache, transitory pains in the maxillary region of the face, pain in the lower jaw and hemoptysis. There was a foul serosanguineous discharge from the nose, as well as hypertrophy of the inferior turbinates, evidence of bleeding from the right side of the nose and edema over the right maxillary sinus. There was a small gray membrane above the right tonsil. The patient's temperature was 100.2 F., his pulse rate 70 and his respiration rate 12. A culture from the throat was positive for diphtheria, and the patient was placed on the usual diphtheria therapy. A roentgenologic examination of the sinuses showed evidence of bilateral antral and ethmoid sinusitis.

With the use of a 10 per cent solution of chloroform in milk spray, a total of one hundred maggots were removed or expelled by the patient by July 7, 1941. The patient was most toxic on July 2 and July 3, 1941, when his temperature rose to 102 F. and his pulse rate to 120. The patient's temperature, pulse rate and respiration rate went down to normal on July 10, 1941, and he was discharged from the hospital four days later.

CONCLUSION

Parasitic flies are found in many parts of the world. With the armed forces of the United States scattered over the globe, every medical officer should be acquainted with disease associated with myiasis of the nose. There are a number of insects, with a wide geographic distribution, whose larvae may attack the human nose.

AERODYNAMICS IN THE PHYSIOLOGY OF THE UPPER RESPIRATORY TRACT

N. VERN PETERSON, M.D.
RYE, N. Y.

IN 1738 BOURNELLI expounded his theory of hydrodynamics. He was concerned with the explanation of why water running through a pipe constricted somewhere in its course seemed to leave at the same speed and in the same quantity as it entered. What took place at the constricted section? Certainly the water must speed up there. What caused this increased flow? He reasoned that the internal pressure at the constricted section must be lower than elsewhere along the pipe, and he actually proved this theory by setting up a series of water gages along the course of this pipe. The same phenomenon was found to prevail with reference to gases. In other words, a rapidly moving

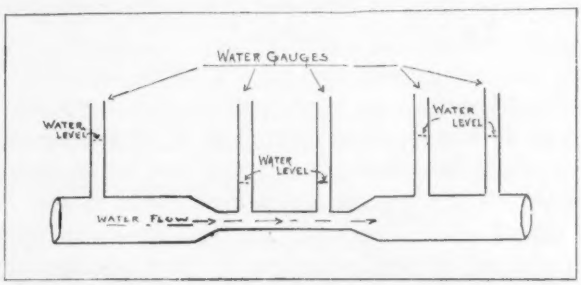

Diagram showing reduced internal pressure at site of constriction in waterpipe.

body of fluids or gases always has a lower internal pressure than that same substance in a state of rest or slower motion. The more rapid the movement the lower the internal pressure.

If two bottles have been filled with smoke and left standing next to each other and if one is exposed only to the ordinary forces of diffusion, while a current of air is passed over the mouth of the other, either in a continuous or in a to and fro stream, one will observe what was suspected, that the bottle the mouth of which is exposed to a current of air loses its opacity long before the other.

A colored fluid behaves in the same manner. If it is exposed to a moving column of air, and hence to an area of lowered internal pressure, it moves to occupy this semivacuum. "Nature abhors a vacuum," and all substances tend to move to occupy the area of lowered internal pressure, gases more readily than liquids and liquids more readily than

solids. This is all demonstrated daily by atomizers. Here liquids and solids (powders) are seen to rise to enter a stream of moving air.

This observation must carry profound implications to otolaryngologists, for they are dealing constantly with cavities the mouths of which are exposed to moving streams of air and the state of health of which depends largely on a free exchange of gases and a free drainage of secretions. This moving body of air with its suction-like action has probably not been given a position of proper importance in the consideration of the health of these cavities. To this extent other factors have been given exaggerated values.

If otolaryngologists admit the existence of this force, and it seems impossible for them to question it, they then face the problem of how to apply it to obtain the optimal effect on the cavities they are concerned with, viz., the paranasal sinuses, the middle ear cavity and the bronchi and bronchioles.

If the current of air in the middle meatus is greatly reduced or is completely cut off, destructive changes are observed in the sinuses of the involved side. One reason, it seems, that a window opening in the inferior meatus fails to drain an antrum well is that no moving column of air passes over its face, the stream being directed rather to the spaces above the inferior turbinate.

If the channel is too wide, and the current is therefore sluggish, as is seen in atrophic rhinitis or in pronounced deviations of the septum, there is little or no suction effect exerted on the communicating sinuses. These then show diseased lining membranes and accumulations of stagnated secretions. The value of surgical procedures in such cases would seem to be almost wholly dependent on their ability to speed the flow of air again past the sinuses, returning to them this suction-like force.

I have always had trouble in treating wet eustachian tubes and the cavities of the middle ear. I still do. However, the application of Bournelli's theory in the last few years has seemed to simplify the problem somewhat.

Patients with this condition usually say that they had a bad cold two weeks to two years ago. Their ears were stuffy and their hearing was impaired. As the cold cleared, the ears seemed to open a little, but there are noises (usually crackling) which persist. These noises, however, may be of almost any character, humming, buzzing or pulsating. The hearing never becoming normal again, the patients may complain of dizziness.

Examinations disclose the usual signs of catarrhal otitis. But in addition there is usually swelling or hypertrophy of the inferior turbinates, especially of the posterior tips. There may even be some polypoid degeneration. In my mind, this tissue is acting to direct the jet of air away from the mouth of the eustachian tube, thereby depriving it

of the drainage effect of a body of air with lowered internal pressure. I try to direct this stream again past the mouth of this tube. This is done by cauterizing the posterior tip of the inferior turbinate; sometimes the posterior half and sometimes the entire length of this structure must be treated.

I have used, for this purpose, almost everything that has ever been suggested from the electric needle to sclerosing chemicals, but of late I have settled on two chemicals, 10 to 100 per cent silver nitrate and chromic acid paste (crystals or flakes of chromic acid melted down in water to a pastelike consistency). I try to select my chemical to suit the tissues with which I must deal. The membranes of a delicate thin-skinned girl respond to much less drastic treatment than those of a tough heavy-skinned mechanic. Then, too, a recent condition naturally calls for much less radical attention than an old one.

In the past three years I have treated 96 patients in this manner. I think that the results have been good, at least better than I had ever known before. All, so far as I know, have become clinically well; i. e., their noises and vertigo cleared, and they say that their hearing has greatly improved. Some have required a long time and a second cauterization. The recovery time has been largely proportional to the duration of the disease. The best results were obtained when the treatment was most radical. So far as I know, only 2 patients have adhesions between the inferior turbinate and the septum. These adhesions appear to be without clinical significance.

Two typical cases are presented:

REPORT OF CASES

CASE 1.—Mr. F. L., 63 years old, was seen March 4, 1943. He was a waiter at a large country club. His history was unimportant except for the fact that his hearing had been failing for some years and that there were "ear noises." One month previously he had had a head cold and a sore throat. His ears were stuffy, and the hearing was greatly impaired. For the past two weeks there had been so much "bubbling in the right ear" that he could not hear orders, and he had become so dizzy and upset that he had had to stop work.

Examination showed a large perforation of the septum (surgical). The middle and inferior turbinates on the right side were greatly hypertrophied, and the posterior tip of the left inferior turbinate showed moderate hypertrophy. There was a moderate mucoid postnasal secretion. He had cryptic tonsils and a large uvula. The drumheads were noticeably retracted and dull, and inflation of the middle ears revealed heavy crackling noises, more pronounced on the right side, and bone conduction was stronger than air conduction on either side. Hearing was not noticeably improved by inflation. He had a loss of hearing in the speech range of 70 decibels on the right side and of 40 decibels on the left.

Almost the entire exposed surface the entire length of the right inferior turbinate was cauterized. One good line was made along the inferior border of the middle turbinate. Chromic acid paste was used.

The reaction was rather severe and painful, and a heavy bloody crust formed, making a cast of the inferior turbinate. Narcotics had to be given for the pain. However, the patient said that his dizziness had disappeared over night and that he heard better the next morning. It was three weeks before this tenacious crust could be removed, and by then there was a foul odor. However, he returned to work after a week, and he was happy even with his stuffy nares. I had visions of complete occlusion of the naris by adhesions, but none developed. At the end of a month, inflation of the middle ears gave a normal reaction on the right side and crackling noises on the left side. There was a loss of only 20 decibels in the speech range on the right side, while the left still showed a loss of 40 decibels. In spite of his bad experience, he wanted the left side "burned"; hence, after three months, because he "still had noises," the left inferior turbinate was cauterized, more judiciously, but with chromic acid paste none the less. In three weeks the left ear inflated with a clear sound, and his audiogram showed a loss of only 30 decibels in this ear.

CASE 2.—Mrs. W., 70 years old, the wife of the manager of a New York hotel, was seen April 4, 1945. She had had noises in her ears for five or six years, and hearing was gradually becoming worse. She had been treated by many competent otologists without help and was told that nothing could be done for her. She had been troubled with dizziness, but now she could not walk, since the dizziness had become so bad in the past week.

The findings were similar to those in the previous case, i. e., bubbling noises on inflation, a negative Rinne test and a loss of hearing in the speech range of about 50 decibels. Hypertrophy was limited to the posterior tips of the inferior turbinates. Both tips were cauterized at one sitting, by means of 25 per cent silver nitrate. She had no pain and needed no analgesic, though she was a frail-looking woman. After three days her dizziness had almost gone. Inflation after two weeks showed only a slight amount of moisture in either tube. Her vertigo disappeared after one inflation. On May 20 her audiogram showed a loss of only 20 decibels in either ear, but she still has some high-pitched ear noises.

The results in all the cases in which I have used this treatment seem to suggest: (1) that aerodynamics plays an important role in respiratory physiology; (2) that this force has been neglected largely, and (3) that it can be directed to help restore normal function in diseased tissues.

Highland Hall.

Abstracts from Current Literature

Ear

THE RELATIONSHIP OF DENTAL MALOCCLUSION TO VACUUM-OTITIS MEDIA AND THE USE OF DENTAL SPLINTS DURING DESCENT FROM ALTITUDES. HOWARD R. BIERMAN and I. W. BRICKMAN, Ann. Otol., Rhin. & Laryng. **55**:5 (March) 1946.

This study, done on more than 15,000 men at the United States Naval Air Station, Pensacola, Fla., showed that in from 10 to 15 per cent of more than 15,000 men ear block developed during recompression. The otoscopic examination confirmed the diagnosis in most cases, but the picture varied considerably and occasionally no changes from normal were seen. A study of the dental occlusion was made in 821 subjects prior to a flight in the chamber and was correlated with the aural difficulties encountered in the descent. Ear block was found to occur five times as frequently in persons with dental malocclusion as in those with normal occlusion. It was also found that movement of the mandible was the most effective means of ventilating the middle ear during descent. A horseshoe dental splint was tried, being put in at 30,000 feet (9,144 meters). The splint was made so that the intermaxillary distance was increased 8 mm. The rate of descent was approximately 5,000 feet (1524 meters) a minute. When one used the splint, there was a decided reduction in the incidence of ear block in persons with malocclusion. It was of no help in those with normal occlusion.

M. V. MILLER, Philadelphia.

DENTAL TREATMENT FOR THE PREVENTION OF AEROTITIS MEDIA. W. J. KELLY and HENRY W. LANGHEINZ, Ann. Otol., Rhin. & Laryng. **55**:13 (March) 1946.

The study was conducted at the United States Submarine Base, New London, Conn., on candidates for the submarine service, to attempt to clarify the contradictory reports of the effect of malocclusion on the development of ear block. In the investigation the men with any interference in mandibular function who showed aero-otitis media following exposure to pressure were taken for treatment. No effort was made to select the men on any other basis, such as amount of adenoid tissue, history of aural disease or similar factors. Only objective observations made by an otologist, independently of the authors, were used as a criterion of success or failure. Careful studies were made of each subject (roentgenograms, casts, studies of articulation of the mandible and similar studies) and treatment instituted to restore an occlusal plane, fully equilibrated, that permitted unhampered movements of the mandible in the various excursions and to provide adequate support in all balancing and working positions.

Over a period of ten months, 50 patients with aero-otitis were treated according to the methods described. After the treatment the men were again submitted to 50 pounds (22.7 Kg.) of pressure and their ears examined by the medical research otologist when they emerged from the chamber. Any man not showing a perfectly normal ear was regarded as having unsuccessful results. Out of the 50 cases, results in 46 were considered successful. In the group of 50 men all types of adenoids were found; 20 of them had adenoids of such size that they covered the ostiums of the tubes. The authors failed to find any correlation between the types of adenoid tissue found in the nasopharynx and the success or failure of a dental treatment which followed the methods of diagnosis and treatment used in this study. Ten of the men in the series if judged by the usual concept of static occlusion would be classed as normal, but when studied in motion pronounced premature and interfering contacts could be demonstrated, causing the condyle heads to assume

strained articular relations, brought about in many instances by aberrant inclined planes on large occlusal inlays and restoration of amalgam. Reduction of the inclined planes to provide unhampered movement in all excursions was sufficient treatment. It was also noted in this series that in cases in which there was unilateral aero-otitis, the occlusal interference in lateral excursion was always on the side away from the affected ear, while in lateral movement on the side away from the normal ear there was little interference. The men were treated by removing the lateral premature contacts on the one side.

The authors' observations support a hypothesis, suggested to one of them by Dr. Stacy Guild, that free lymphatic drainage of the middle ear and eustachian tube is interfered with by fascial and muscular tensions due to abnormal jaw movements and that restoration of normal movements in some manner permits a free drainage of lymph, which in turn quickly relieves mucosal congestion of the eustachian tube. They give anatomic and physiologic facts to support this theory, and they state the belief that the elimination of functional restrictions of the buccinator muscle—and hence the superior constrictor due to their interrelation through the pterygomandibular raphe—by dental equilibration and restoration of a normal intermaxillary distance, reestablishes the "milking" action on the lymphatic vessels and removes the tourniquet effect. They express the opinion, too, that the theory of lymphatic stasis is further borne out by the fact that the amount of lymphatic tissue present in the nasopharynx had little bearing on the success or failure of this method of dental treatment.

M. V. MILLER, Philadelphia.

THE TREATMENT OF CHRONIC OTITIS MEDIA. T. M. BANHAM, J. Laryng. & Otol. **60**:307 (Aug.) 1945.

This is a superior, concise clinical and statistical article on the treatment of chronic otitis media. It should be read to be thoroughly appreciated.

The details of the conservative method of treatment are described. Two hundred unselected cases of chronic suppurative otitis media were subdivided as to the site of the perforation. Dry ears were obtained in 93 per cent of the central perforations, 82 per cent of the attic perforations and 49 per cent of the marginal perforations. A total of 165 patients obtained dry ears.

The central, attic and marginal perforations were further subdivided as to the type of pathologic condition present in each. The average length of time required to obtain the dry ear was shown for each pathologic type of each perforation.

As these patients were in the Royal Air Force, there was excellent follow-up on a large percentage of the group. The number of recurrences was tabulated, as was the response of these recurrent lesions to subsequent treatment.

Comment: This article indicates the satisfactory results which may be obtained from the diligent treatment of chronic suppurative otitis media. In conclusion, Squadron Leader Banham states, "However, if the ear is likely to be neglected and further treatment not obtained if a recurrence occurs, some form of radical mastoidectomy is probably a safer end result."

LEJEUNE and FARRIOR, New Orleans.

OPERATIVE TREATMENT OF CHRONIC OTITIS MEDIA. W. O. LODGE, J. Laryng. & Otol. **60**:315 (Aug.), 1945.

The author briefly describes the pathologic types of chronic otitis media, classifying them into (1) those with circumscribed disease of the attic; (2) those with attic and antral disease and partial involvement of the middle ear, and (3), finally, the advanced disease, with complete involvement of the antrum, attic and the middle ear.

The author favors the endaural approach in 90 per cent of the cases of otitis media and sutures a meatal flap upward along the anterior superior canal wall and roof of the cavity.

The author states that a radical mastoidectomy is an "operation of access" and stresses the value of careful after-treatment.

Comment: The article is filled with many unsupported statements, which in academic discussion would stimulate debate.

LEJEUNE and FARRIOR, New Orleans.

COCHLEAR DEAFNESS. A. J. WRIGHT, Proc. Roy. Soc. Med. **39**:265 (March) 1946.

Wright expresses the opinion that there are a large number of cases of perceptive deafness without vertigo which belong to the entity of Ménière's disease. He states that the cochlear lesion of this disease precedes the vestibular in the majority of cases and often for a long period. The clinical picture thus presented is that of tinnitus variable in type and degree, with progressive deafness, which is usually unilateral. The deafness tends to be variable and is often accompanied with hyperacusis and paracusis. It is perceptive in type, but tuning fork tests are liable to mislead if masking of the better ear is not employed. A sense of fulness in the affected ear is usual, and inflation may produce a short-lived improvement in the hearing.

CAMPBELL, Philadelphia.

VESTIBULAR INJURIES. TERENCE CAWTHORNE, Proc. Roy. Soc. Med. **39**:270 (March) 1946.

Cawthorne's paper is based on a study of the effects of destruction of the end organ of the vestibular nerve in the labyrinth for the relief of Ménière's disease in 120 cases and on the detailed otologic examination of a series of 58 patients with closed head injuries whose convalescence was protracted mainly on account of disturbed balance. In both groups vertigo was the predominating symptom, while the most constant and in many the sole physical sign was an abnormal response to caloric stimulation of the labyrinth. The chief clinical feature was the overwhelming vertigo, nausea and turbulent eye movements, all enhanced by the slightest movement of the head. Within a few days of the injury the acute phase died down, leaving a residue of effects, in which vertigo played a prominent part. Other symptoms are instability in the dark and on moving up and down stairs or on an inclined plane and a tendency to tire quickly on physical exertion. Headache, which is a common sequel of concussion, is usually not seen after operation on the labyrinth. Of the 58 patients with head injury who were submitted to a full otologic examination, 56 showed deviations from the normal in their response to caloric stimulation of the labyrinth, and of these 56 only 24 had damage to the cochlea. Cawthorne concluded from his observations that in persistent vertigo following concussion the vestibular end organ is a likely seat of the damage. In helping these patients to adjust this situation, he found it important to explain to the patient the state of his condition and institute graduated exercises to encourage movement of head and eyes.

CAMPBELL, Philadelphia.

REHABILITATION IN VESTIBULAR INJURIES. F. S. COOKSEY, Proc. Roy. Soc. Med. **39**:273 (March) 1946.

The symptom complex for which Cooksey had to provide a system of rehabilitation consists of headache, vertigo, including the so-called "black-outs," impaired mental concentration and deafness in a proportion of cases. The headaches are often persistent and difficult to alleviate. To assist recovery from such symptoms there were employed graduated physical exercise, mental exercise and occupational therapy.

The physical exercises are designed to restore balance as far as possible and to train the eyes and muscles and joint sense to compensate for permanent vestibular dysfunction. The mental exercises consist of play reading, debates, "brain trusts" and organized study. With the occupational therapy the object is to train the

patients to concentrate and to perform the quick and involuntary movements of normal activities. It is also useful to train them to work under crowded and noisy conditions.

CAMPBELL, Philadelphia.

Nose

FRONTAL SINUSITIS. J. M. BROWN, Laryngoscope **56**:116 (March) 1946.

Brown lists the indications for surgical intervention in frontal sinusitis. He uses a trephine opening made in the floor of the frontal sinus at its inner angle. The opening then is enlarged somewhat, but no other surgical treatment is given. The wound is drained and later closed. Brown believes that this procedure done early in the disease has prevented many complications. The cosmetic results are good.

Complications of frontal sinusitis and their management are discussed. An operation for chronic frontal sinusitis is described.

HITSCHLER, Philadelphia.

OCCULT MAXILLARY ANTRUM INFECTION. JOSEPH POPPER, New York State J. Med. **46**:1019 (May 1) 1946.

Popper reports 3 cases of infections of the antrum in which there were no symptoms referable to the nose. He notes that in "the average case" there is acute coryza with persisting discharge which gradually becomes copious and purulent. There is discomfort or pain in the face or in the eye. Obstruction to breathing on the affected side is common. In the cases mentioned, diagnosis was made by transillumination and irrigation of the antrum. The third case is of interest because of a persistent cough which cleared up after an infected antrum had been irrigated. This woman "had no nasal symptoms whatever." The second patient had pain and disability in her left leg and was under care of an orthopedic surgeon. Sinusitis was not suspected, but the tonsils were removed because of a long history of sore throat. The "rheumatism" became worse and extended to other extremities. One month later a slight trickle of pus was discovered in the right middle meatus. Transillumination gave a definite shadow over the right antrum. Irrigation produced foul greenish yellow pus. In about three weeks the disability in her limbs improved, and six months later "she was practically well."

Latent sinusitis is no new thing, but it may well remain undiscovered unless tne physician is diligent in making the initial examination complete in every detail. This includes transillumination and roentgen examination of the sinuses and irrigation when feasible.

VOORHEES, New York.

NASAL INJURIES AND THEIR IMPLICATIONS. MATTHEW S. ERSNER, Pennsylvania M. J. **49**:840 (May) 1946.

The author gives a rather complete description of nasal injuries and their sequelae His comments and conclusions are as follows:

"1. Nasal injuries may terminate in developmental defects, hematoma, septal abscess, fracture, deviated septum, disturbance in normal nasal physiologic function, trigger points, middle ear involvement and other otitic conditions, psychosomatic factors, or external nasal deformities.

"2. Nasal injuries may require a certain amount of nasal reconstruction in order to bring anatomic abnormalities and distortions within the normal range.

"3. After parturition, it should be the routine practice of every obstetrician to inspect and palpate the infant's nose for septal deflection, nasal dislocation and fracture. It is best to correct such deformity immediately before a greenstick fracture results or a callus forms.

"In passing, it might be mentioned that one has only to grasp the tip of the nose with the thumb and index finger, gently but firmly pulling it from side to

side, or tugging the tip of the nose slightly ventrally. One can usually feel or even hear the snap of the reduced dislocated cartilage.

"4. X-ray studies should be made of nasal fractures in order to determine the type of fracture and also to ascertain if the fracture has been properly reduced.

"5. The importance of correcting a fracture of the nose before edema occurs cannot be overemphasized. When absorption, callus formation, or ossification have already taken place, it is much too late to reduce the fracture. Instead, we have a problem of reconstructive surgery.

"6. Submucous resection is a modern step in intranasal surgical procedure and is only one of the phases in nasal reconstruction.

"7. The importance of re-establishing normal nasal physiologic function cannot be overemphasized.

"8. To prevent a saddle nose after submucous resection, it would not be amiss to replace a segment of the resected septum between the flaps of the mucous membrane. This will lend rigidity to the septum and thus minimize oscillations and eddies.

"9. Where plastic surgery is necessary for the correction of an external deformity, the nose should be properly balanced in order to conform with the general contour and dimensions of the face.

"10. The psychogenic phase should be taken into consideration in those individuals who might develop a definite emotional reaction to an external nasal deformity.

"11. Since many septal deviations are concomitant with external nasal deformities, the attention of the profession is now being directed to the fact that surgery of both the internal and external nose can be combined in a one-stage operation. Thus we not only re-establish normal nasal physiologic function but improve the cosmetic appearance of the patient as well."

DAVISON, Danville, Pa.

DISCUSSION ON PENICILLIN IN RHINOLOGY. SIMSON HALL and Others, Proc. Roy. Soc. Med. **39**:279 (March) 1946.

1. Simson Hall confined his remarks to the treatment with penicillin of patients with frontal sinusitis with complications. Each patient had osteomyelitis, 2 had subperiosteal abscess, 1 had meningeal irritation and 1 had established meningitis and abscess of the frontal lobe. The organism in 3 cases was the staphylococcus, in 1 nonhemolytic streptococcus and in 1 hemolytic streptococcus. The only operative treatment carried out in his department was the insertion through a ½ inch (1.27 cm.) incision and a trephine hole of a fine rubber tube into the frontal sinus. Through the tubes the sinus was irrigated with a saline solution and a known dose of penicillin was injected at frequent intervals. In 1 case a double intranasal antrostomy was also carried out. Continuous parenteral administration was also used. The result of this treatment was that all sinuses were healed and dry and without nasal discharge in less than three weeks.

2. R. H. Hunt Williams stated that in order to perfuse the sinuses with penicillin by local applications the displacement method as advocated by Proetz could be used or repeated puncture made and fluid injected. Five patients with acute or subacute sinusitis were treated by these local methods, with apparently excellent results. A further series of 8 patients with chronic sinusitis was treated, with, on the whole, disappointing results.

3. J. F. O. Mitchell made a report on the local use of penicillin in the nose and throat. In the treatment of patients having tonsillectomy, penicillin in lozenge form was used and found to greatly improve the local condition and to lessen the discomfort. He found also that Vincent's infection rapidly resolved under penicillin therapy in lozenges and that in early or catarrhal tonsillitis this therapy produced clinical and bacteriologic cure within two days.

Penicillin was used in the nose as a powder diluted with dextrose to which was added 0.25 per cent menthol. In the treatment of the common cold this penicillin snuff administered two hourly for four days seems to prevent the secondary invasion of pyogenic organisms and if they have already gained a foothold will "eliminate the purulent discharge and cure in the majority of cases."

4. E. J. Collins, P. D. Eeman and A. R. T. Lundie used penicillin locally (by lozenges) in tonsillectomy and found that the amount of exudate that formed in the tonsillar bed of the patients treated was not nearly so great. As a result, the slough was not so deep and the wound healed with far less scarring of the faucial pillars.

5. R. G. Macbeth investigated the use of penicillin administered by the displacement and irrigation methods in cases of sinus and laryngeal infections. The residual ethmoiditis responded well, but in acute infections of the frontal and maxillary sinuses the displacement method had been disappointing.

6. G. E. Martin cited 4 patients with osteomyelitis of the frontal bone treated by penicillin after operations. Two of these patients died of brain abscess, and a brain abscess developed in a third but he recovered after drainage of the abscess; the condition of the fourth cleared up satisfactorily.

7. R. J. V. Pulvertaft discussed some of the possibilities of the use of penicillin by inhalation.

8. A. S. H. Walford favored the use of penicillin by instillation into the antrums in infection.

9. T. B. Johnson cited a patient with long-standing drainage from an antrum who had had a radical operation which was cleared up by administration of penicillin systemically and locally.

Others described treatment of individual patients, expressed opinions on the prophylactic use of penicillin and further discussed the methods of administration and dosage of penicillin.

CAMPBELL, Philadelphia.

Miscellaneous

THE RELATIONSHIP BETWEEN VOLUNTARY NON-FLUENCY AND STUTTERING. JAMES HYDE MEISSNER, J. Speech Disorders **11**:13, 1946.

Twenty-four stutterers, 8 females and 16 males, of ages ranging from 13 to 22, who were undergoing corrective work in the Speech Clinic of the University of Iowa, read three experimental passages in which they were required to read with nonfluency varying percentages of the words, and then to proceed immediately to control passages on which no voluntary nonfluency was required (nonfluency or voluntary stuttering consists of repetition of initial consonants and other sounds at a controlled rate). Conclusions reached were as follows: 1. The frequency of stuttering in the immediate context of words which are produced with voluntary nonfluency is significantly less in passages in which 50 or 25 per cent of the words are nonfluently produced than in passages in which either none or 5 per cent of the words are nonfluently spoken voluntarily. 2. This differential effect is not to be observed in the over-all frequency of stuttering in those control passages which immediately followed the experimental passages. 3. Significantly greater amounts of stuttering occur on words which have the larger number of the following attributes: initial consonant, initial position in the sentence, word length greater than five letters and grammatical function of noun, verb, adjective or adverb. 4. The conclusion concerning stuttering in relation to word weights also applies to errors in producing words with voluntary nonfluency, more such errors occurring on words in the higher weight categories.

PALMER, Wichita, Kan.

A NOTE ON A LINGUA-VELAR RELATIONSHIP. ROBERT HARRINGTON, J. Speech Disorders **11**:25, 1946.

It is possible that in certain phonetic elements there is a proportionate relationship between the elevation of the tongue and the elevation of the velum. Roentgen

studies to date have not controlled many of the variables in the technic of studying this phenomenon. There is no muscular relationship which would explain it.

PALMER, Wichita, Kan.

INFANT SPEECH VOWEL AND CONSONANT TYPES. HAN PIAO CHEN and ORVIS C. IRWIN, J. Speech Disorders **11**:27, 1946.

Sixteen hundred and twenty-two records of infant speech produced by 95 infants from birth to 2.5 years were studied by means of an equation derived from the means of the vowel types, $V_T = 5.42A^{0.274}$, and the equation derived from the means of the consonant types, $C_T = 2.911A^{0.622}$. During the first year the mean number of vowel types exceeds the mean number of consonant types. After this the situation is reversed. At 2.5 years the infant possesses practically the full complement of vowels and two thirds of the full complement of consonants. It is suggested that the equations may be considered the expressions of the two laws of phoneme type development during infancy.

PALMER, Wichita, Kan.

DESENSITIZATION BY HISTAMINE (HISTAMINE AZOPROTEIN) IN VERTIGO, PERIODIC HEADACHES AND VASOMOTOR (ALLERGIC) RHINITIS: REVIEW OF THE LITERATURE AND REPORT OF 102 CASES. J. W. McLAURIN, Laryngoscope **56**:253 (June) 1946.

It is thought that allergic reactions are caused by the release of histamine into the system. If the body can be desensitized to histamine, no such reactions will occur. Desensitization can be accomplished by injections of histamine azoprotein.

McLaurin treated patients with vertigo tinnitus and deafness (Ménière's disease), certain periodic headaches, allergic rhinitis and aural dermatitis by such desensitization.

Many of these patients had been previously treated by other means, without success. The author's results were excellent.

Reports of illustrative cases and a bibliography are appended.

HITSCHLER, Philadelphia.

News and Comment

ANNUAL GRADUATE CONVENTION IN OTOLOGY, RHINOLOGY AND LARYNGOLOGY

The Eleventh Annual Graduate Convention in Otology, Rhinology and Laryngology will be held at the University of Cincinnati College of Medicine, April 14 to April 19, inclusive. It will consist of an operative course on the cadaver and didactic lectures.

Society Transactions

AMERICAN LARYNGOLOGICAL ASSOCIATION

Sixty-Seventh Annual Meeting, May 29 and 30, 1946

Harold I. Lillie, M.D., *President*

Abstracted by Samuel Salinger, M.D.

Osteomyelitis of the Maxilla; Presidential Address. Presented by DR. H. I. LILLIE, Rochester, Minn.

Dr. Lillie devoted the major part of his address to a discussion of osteomyelitis of the maxilla secondary to suppurative maxillary sinusitis, particularly osteomyelitis of the malar bone secondary to operations on the maxillary sinus. He compared the treatment which includes the modern use of sulfonamide compounds and penicillin with the time-honored methods of treatment used heretofore. He feels that with the use of sulfonamide compounds and penicillin the prognosis has been greatly improved. Also, he warned that the infection may be due to an anaerobic organism, and emphasized that the infecting organism should be identified if well directed chemotherapy or the use of antibiotics is to be employed as adjutant treatment. He drew attention to the difference in symptomatology and pathology between osteomyelitis of the malar bone and osteomyelitis of the frontal bone. He still feels that the infection spreads from around the nasolacrimal duct and sac to the malar bone. The first symptom is severe pain in the face, increasing in severity, that manifests itself several days after any operation. No physical signs are evident until two or three days have elapsed. Then redness and swelling occur in the region of the lacrimal sac and spread out over the malar bone. Edema of the lower eyelid and face becomes a prominent sign. At this stage there is little or no evidence of involvement of the interior of the lacrimal sac. The disease, therefore, is not a form of dacryocystitis. He quoted Wolff's anatomic description of the lacrimal sac and duct and explained the various stages of the syndrome on an anatomic and pathologic basis. Surgical intervention is deferred until definite evidence of suppuration or sequestration has taken place. The extent of sequestration that will occur depends on the caliber of the vessel that has been thrombosed by the disease process.

Available literature was reviewed; this review makes it apparent that the fatality rate of this type of disease is high. Extension of infection takes place through the angular veins to reach the meninges and the cavernous sinus. Lillie reported that 1 patient succumbed after the infection extended to the meninges and the cavernous sinus. Penicillin was not available for the treatment of this patient. In a subsequent case in which penicillin was used, suppuration or sequestration did not take place.

(No discussion)

Rhinosporidiosis. Presented by DR. FRANK R. SPENCER, Boulder, Colo.

This is a tropical disease caused by a fungus known as Rhinosporidium seeberi. It has been reported in East India, Argentina and the United States. The growth in the nose looks much like a nasal polyp. The tumor is redder, rougher and more vascular than an ordinary polyp. It is friable and bleeds easily. It may be attached to the septum or to one of the turbinates. The colonies of the fungus can be seen with the naked eye, as fine gray or white dots.

These should be removed by surgical diathermy, and the fluid in the tumor should not be allowed to come in contact with the normal mucous membrane. Recurrences are almost certain to occur.

DISCUSSION

DR. JOHN J. SHEA, Memphis, Tenn., commented on the difficulty of culturing the spores, which has resulted in much confusion among mycologists. Dr. Shea reports having seen 2 cases of this disease, in one of which the tumor mass was attached to the septum. A specimen sent to the Army Museum's laboratory was reported as "plasmocytoma." Dr. Shea showed a slide which depicted a foreign body granuloma about the spore. The central body of the spore is a chromatin body which multiplies many times and then ruptures as the body is forced to the surface. Fragments of the ruptured chromatin are thus deposited in the tissue, causing an increase in the size of the lesion and production of new granulomas.

DR. H. V. PENTA called attention to the similarity between the histopathologic picture in the slide shown by Dr. Spencer and that of infection with Coccidioides immitis. The latter fungus, like the one shown by Dr. Spencer, grows by forming endospores which rupture when the tension reaches a certain point. Dr. Penta stated that he has seen lesions of this type in the skin.

Some Comments on Cleft Palate and Lip. Presented by DR. H. G. BEATTY, Columbus, Ohio.

This article concerns only clefts of the hard and soft palate and does not include clefts of the alveolar process.

It is in cases of defects of this class that the operator has the best opportunity to secure perfect or nearly normal speech as the child operated on grows. Therefore it seems that the simplest and least traumatic procedure should be used.

Dr. Beatty referred to the technic established years ago by the late Dr. Truman Brophy. There have been some changes made in his original technic, but the general principles have been used in a large number of patients, with excellent results when no complications have intervened.

DISCUSSION

DR. WARREN B. DAVIS, Philadelphia, mentioned the variety of procedures employed in these cases with the same end in view. He called attention to the present trend toward operating earlier in life. As a rule, the patients are now being operated on at the age of 15 to 20 months. He agreed with Dr. Beatty on the importance of preoperative care and stressed particularly the elimination of disease of the ethmoid cells, which in his experience has contributed to the incidence of postoperative infection. He differs with Dr. Beatty on the point of the one stage operation, preferring to do the work in two stages. It is his contention that the child can stand two short operations better than one long one. Besides, the interval affords some time for the establishment of collateral circulation.

On the basis of an experience in 4,600 cases, encountered since 1913, Dr. Davis feels that he has obtained better results with osteoplastic than with mucoperiosteal flaps. There is less scar contraction in the former. Also he is convinced that with the two stage operation the mortality is lowered, greater length is obtained in the palate, and the resulting voice is better.

DR. THOMAS E. CARMODY, Denver, agreed on the importance of roentgen examination of the thymus but did not feel that it is needed after the age of 2 years. He has not had as much success with osteoplastic flaps as Dr. Davis and follows pretty closely the technic described by Dr. Beatty.

Dr. Carmody finds that the feeding problem is materially improved by intravenous injections of dextrose solutions, which are given for the first five or six days. He agrees with Dr. Beatty that narcotics should not be used in these cases; neither does he approve of the use of atropine.

Like Dr. Beatty, Dr. Carmody elevates the mucoperiosteum; he also splits the soft palate as described by Gilbert. However, instead of using catgut for sutures, he employs horsehair or some other nonabsorbable material.

Dr. Carmody is conscious of the role of the sinuses in secondary infection and also calls attention to the possibility of infection passing up the eustachian tube to the

middle ear, due to the prolonged position of the child on its back. Cooperation on the part of the pediatrician and careful nursing can do much to mitigate such complications.

Dr. Francis L. Lederer, Chicago, emphasized the importance of the effect of the operation on the speech mechanism. Careful attention to speech training has in some institutions been given 70 per cent of the credit ascribed for good results in this direction.

Dr. F. R. Spencer stated that the service of speech therapeutists of the medical school at Denver has proved of inestimable value in the follow-up of these cases.

Dr. Beatty, in closing, agreed that speech training is highly important. It is one reason why early operation, prior to the development of bad speech habits, is so essential. However, it may all come to naught if the operation itself leaves the patient with a short, scarred palate or one that is imperfectly attached.

Danger of Unrecognized Anoxia in Laryngology. Presented by Dr. Thomas C. Galloway, Evanston, Ill.

Dangerous anoxia is frequently unrecognized and untreated. Symptoms due to oxygen want are often mistakenly ascribed to infection or to other disease. Many experiments show that even brief periods of anoxia leave definite changes in the brain tissue of experimental animals. Likewise, postmortem studies indicate that anoxia may produce far reaching destruction or injury of brain tissue in human beings. Probably even one or two minutes of oxygen want does not leave the brain tissue unscathed. Also, in patients surviving serious anoxia there are far reaching effects varying from emotional flattening to decerebrate states, although the causal relationship is often missed.

Of the four main types of anoxia, the laryngologist is chiefly concerned with the anoxic type. Symptoms of restlessness, mental changes, dyspnea, cyanosis and changes in the cardiac and respiratory functions may be obscured or may not be dissociated from the primary disease. Especially in bulbar poliomyelitis have certain symptoms been ascribed to the virus which must be due to anoxia, since they speedily disappear on clearing the airway.

The prevention of oxygen want and its correction are especially important in anesthesia, shock, tracheobronchitis and other respiratory obstructions.

DISCUSSION

Dr. Henry M. Goodyear, Cincinnati, stated that there is a definite relationship between juvenile delinquency and whooping cough occurring in infants under 2 years of age. This was corroborated by observations made in a hospital for delinquent children. This would seem to be a good argument in favor of early inoculation against this disease. Dr. Goodyear believes that greater care should be exercised in administering anesthetics to young children for the removal of tonsils and adenoids. If nitrous oxide is used for induction, a sufficient amount of oxygen should be given to counteract possible mild anoxia. Also, the anesthetic should be withdrawn early even if there are signs of impending emesis.

Dr. Frederick T. Hill, Waterville, Maine, believes the important factor in surgical shock is anoxia of tissues. He referred to some experimental work done by Dr. Porthus at the New England Medical Center, in which it was shown that venous blood returning to the heart contains a certain amount of oxygen and that by using cytochrome C (an iron-porphyrin protein which promotes oxidation of tissues) it is possible to increase the tissue absorption of oxygen. Experiments on rats showed that even when there was a severe degree of anoxia the survival rate was markedly increased by the use of this medicament. In human beings it was observed that the visual disturbances of anoxia and the electrocardiographic and electroencephalographic changes likewise could be prevented by preliminary intravenous administration of cytochrome C. This element is derived from vitamin B_1; it is stable and nontoxic. It has been successfully employed in barbituric acid poisoning.

DR. W. LIKELY SIMPSON, Memphis, Tenn., mentioned the importance of having a laryngologist serve as chairman of a committee of the staff to supervise the activities of the department of anesthesia.

DR. GORDON B. NEW, Rochester, Minn., asked a question regarding the group of cases of poliomyelitis mentioned by Dr. Galloway in which tracheotomy was performed. In his experience with cases of bulbar poliomyelitis, death usually resulted from involvement of the intercostal nerves, and he wished to know in just what percentage of cases tracheotomy was indicated, or how it was determined that in certain other cases recovery would ultimately occur without this procedure.

DR. DE FOREST C. JARVIS, Barre, Vt., called attention to the fact that natives living in the Andes Mountains at altitudes up to 16,000 feet were in the habit of eating the seeds of kelp obtained from the Pacific Ocean. This led him to believe that the ingestion of oxidizing agents, such as kelp, iron, manganese and copper, is effective in relieving anginal pains due to cardiac anoxia.

DR. GALLOWAY, in closing, agreed with Dr. Goodyear that delinquency of children might be due to anoxia in whooping cough, especially if associated with atelectasis. He has also been concerned about the dangers of general anesthesia in children. He was interested to learn from Dr. Hill of the use of cytochrome C. In answer to Dr. New he stated that respiratory difficulty in poliomyelitis may be described as of three types: (1) paralysis of the intercostal muscles and diaphragm; (2) lack of rhythm and coordination of medullary origin; (3) central involvement affecting deglutition. In the first, patients do well in a respirator. The second type may be due largely to accumulation of secretions. The third certainly is, and the patient may draw in his own secretions, especially if he is in a respirator and aspiration is imperfectly done. In such cases tracheotomy can prevent asphyxia by short-circuiting the pharyngeal accumulation and permitting direct aspiration from the lower air passages. As a rule, pharyngeal paralysis is of short duration, and function is restored relatively soon. During the crucial period tracheotomy is often life saving.

Some Causes of Hoarseness in Children. Presented by DR. FRANCIS W. WHITE, New York.

The objectives of the paper are to call attention to the fact that the laryngologist is not consulted frequently enough or early enough and to emphasize that the causes of the disagreeable changes are often remedial conditions and not always just associated with mutation.

All of the children were seen at the clinic of the Manhattan Eye, Ear and Throat Hospital over a period of many years. The author worked in a voluntary capacity in connection with the department of speech improvement of the public school system of New York.

A syllabus is given to expedite the examination of patients. Case histories are noted of both congenital and acquired forms of causes. Mention is made of the ill effects, both social and economic, of being ridiculed during the sensitive or formative years at or about puberty. Pupils with remedial conditions may be separated from classes for group instruction, thus saving the time of all concerned. The effect on the morale of the pupils is marked.

Hearing should be tested in all cases, as a child who does not hear words well cannot repeat them correctly. Cooperation between laryngologist and other related specialists, endoscopist, laboratory staff and members of the child's family is necessary. Instilling a sense of pride at possessing a pleasing rather than a disagreeable voice is helpful.

The foregoing and many other points are brought out, and the fact that so many children of numerous nationalities and various ages could be examined by the direct method is of interest. The article is well worth the time of reading.

DISCUSSION

DR. LOUIS H. CLERF, Philadelphia, emphasized the importance of direct inspection of the larynx of the child whose voice is hoarse. With patience this may be accomplished with the mirror, although in some cases direct laryngoscopy is necessary. In his experience hoarseness is in most instances due to screaming and yelling at outdoor sports. Treatment requires considerable tact and cooperation on the part of the parents and the teachers.

DR. WHITE, in closing, spoke of the lack of cooperation of the patient and the family, especially if the condition is pronounced, not dangerous. The services of a speech teacher may be of some assistance.

Aphonia. Presented by DR. C. H. MCCASKEY, Indianapolis.

Aphonia is defined as a loss of voice, but it is a loss which is not due to a central lesion. It is important to examine the etiologic factors causing hysterical aphonia. The psychosomatic conception of hysteria should be discussed, as aphonia is only one of the many symptoms.

The manifestations of hysteria are myriad and almost any organ or organ system may be the site of these manifestations. When the basic mechanism of hysteria is found, some type of conversion is usually found; that is, an emotional problem is converted into a physical manifestation.

An example of this is cited in the case of a soldier who has been ordered to a dangerous position. His conscience forces him to advance, but he is held back by fear of pain, etc. His emotions may be converted into physical difficulties, such as paralysis of the legs, blindness or convulsions. This conversion phase allows him to escape from a distasteful situation without loss of personal esteem.

Persons badly spoiled in childhood, persons who are emotionally immature and fundamentally childish in their attitude toward life, and similar types of self-indulgent persons will oftentimes utilize this method of escape.

The conversion and production of physical symptoms may occur unconsciously, and the patient may not be aware of the nature of his symptom or of its cause. If the total situation of the patient is investigated carefully, it will be found that the hysterical or conversion aphonia in some way symbolizes a problem and offers a solution to it.

A number of cases are reported to substantiate the discussion. In each case the aphonia was merely the presenting symptom of a major emotional disturbance and represented the only avenue of escape from a difficult dilemma.

Treatment directed only toward the aphonia may be successful in restoring the voice by direct and often preventive methods of improving function of the larynx. The removal of the symptom, however, leaves the patient with unsolved conflicts, and these conflicts may soon be converted into symptoms elsewhere in the body. Treatment must be directed also toward the basic emotional problem. Many times the treatment must be of a psychiatric type.

Summary.—Aphonia is defined as a loss of voice but it is a loss of voice which is not due to a central lesion. It may well be called conversion aphonia. It is a symptom and, as such, local treatment should not be stressed. An attempt should be made to find the cause of the emotional instability and see that it is corrected. This is a safe method of solving the problem. Psychiatry is an able adjunct to the treatment of this type of aphonia in many cases.

DISCUSSION

DR. RALPH A. FENTON, Portland, Ore., called attention to the physical changes which may appear in these cases and which require therapy. Too much emphasis on the psychologic angle with young patients may not be desirable. Even when the problem is principally a psychoneurotic one, the laryngologist should be able to solve the difficulty in most cases without the assistance of a psychoanalyst.

DR. ERNEST M. SEYDELL, Wichita, Kan., commented on the mechanism of the transference phenomenon and described his procedure of provoking a cough and putting the patient through humming exercises, followed by external finger pressure on the larynx and other suggestive procedures which at his hands have yielded excellent results.

DR. FRED Z. HAVENS, Rochester, Minn., as well as Dr. Seydell, mentioned the high-pitched character of the voice in some of these patients who are not strictly aphonic but suffer rather a form of dysphonia. They are treated by procedures the same as those outlined by the essayist.

DR. GORDON F. HARKNESS, Davenport, Iowa, emphasized the objective picture of functional aphonia in which the normal-appearing cords, on attempted phonation, move inwardly but relax at the moment approximation is imminent.

DR. ROBERT C. MARTIN, San Francisco, described a type of pseudoaphonia encountered in aviators at high altitudes where the reduced air pressure interfered with the sound of the voice over the intercommunication system. With the advent of the B-29 and its pressure chambers this difficulty was overcome.

DR. MCCASKEY, in closing, again emphasized the importance of getting to the bottom of the psychologic complex which brings this condition about. Local therapy alone may result in only temporary improvement, and relapses are common unless the patient and the family are convinced that the condition is not due to any local pathologic change.

Associated Paralyses of the Larynx. Presented by DR. C. C. CODY JR., Houston, Texas.

DISCUSSION

DR. FRANCIS L. WEILLE, Boston, brought out the fact that the bulbar cortical-spinal tract differs from the pyramidal tract in that it decussates once, whereas the pyramidal tract decussates twice—that is, first, just above the cord at the beginning of the medulla and again lower down. Also, the question is asked whether the cranial portion of the eleventh nerve supplies both vocal cords through the tenth, it being his understanding that such is the case. Concerning the differentiation between spastic and flaccid paralysis of the larynx, Dr. Weille felt that the only way a differentiation could be made would be by inference from the status of the associated paralyses of other muscles.

DR. CODY, in closing, called attention to the fact that the controversy over the role of the eleventh nerve in the innervation of the larynx has been the topic of debate for many years, with no agreement in sight. It is difficult to trace all the fibers of the nucleus ambiguus because by the time they reach the surface of the medulla their relative positions have changed. He is satisfied that in most cases that part of the nucleus ambiguus supplying the spinal accessory nerve does not usually arise in the medulla but in some such place as that suggested by the Jackson, Schmidt and Tapia syndromes. In the presence of torticollis associated with paralysis of the larynx it would be reasonable to assume that the nerves arose from cells that were in close juxtaposition.

As for the diagnosis of spastic paralysis, Dr. Cody has found that the cords tend to overact on phonation, which results in a hoarse, husky, explosive kind of voice. This applies, of course, only to the cases of bilateral involvement.

Intralaryngeal Surgical Operation for Selected Cases of Laryngeal Cancer. Presented by DR. F. E. LE JEUNE, New Orleans.

Intralaryngeal dissection for certain types of malignant lesions of the larynx has never gained popularity. The accepted surgical procedures for cancer of the larynx have been laryngofissure and laryngectomy, the choice of the procedure depending on the extent of the lesion. However, a less extensive operation which still

eliminates the lesion can be performed if the growth is in the early stages of development, small in size, limited to one vocal cord and completely surrounded by normal cordal tissue. This operation has the following advantages: simplicity, no external incision, preservation of the continuity of the thyroid cartilage, better postoperative phonation, shorter hospitalization and good prognosis. Intralaryngeal extirpation of the lesion is not difficult when accomplished by means of suspension laryngoscopy. After the growth has been excised together with a general margin of healthy tissue, the base of the lesion is electrocoagulated.

Of 39 patients operated on by the intralaryngeal route, 19 have survived the five year period, 15 are living and well from one to five years after operation, 2 have been operated on too recently for one to know the result and 3 had recurrences.

DISCUSSION

DR. GEORGE J. TAQUINO, New Orleans, who was associated with the late Dr. Lynch at a time when the latter was doing a number of intralaryngeal excisions, has followed this technic for a number of years and recalls having shown 10 patients of his own at the Graduate Medical Assembly in New Orleans two years ago, all of whom were well and without recurrence for periods of from two to seven years. It has been his custom to do a wide excision, followed by electrocoagulation of the base.

DR. FRED Z. HAVENS, Rochester, Minn., reported having successfully performed this operation in a few selected cases, with excellent results. He feels that the procedure has a definite place in the laryngologist's armamentarium but that it is not the sort of thing to be carelessly adopted. It requires not only skill of a high order but mature judgment in the selection of cases.

DR. SAMUEL SALINGER, Chicago, did not believe that the procedure described by Dr. Le Jeune would be misapplied or substituted for more radical technics indiscriminately. In his own experience a lesion has rarely been seen early enough to be amenable to it. He could recall only 2 instances in which it was employed: in one case it was used because the patient refused an external operation, and in the other, because the lesion was so small that it was entirely removed as a specimen for biopsy. Both patients remained well. He believes that with increasing attention being focused on the problem of cancer through newspaper and magazine publicity, more patients may appear early enough for this procedure. He feels also that suspension laryngoscopy affords the best approach, since the field is thus widely exposed and both hands are free to work.

DR. C. C. CODY, Houston, Texas, emphasized the importance of regarding all papillomas as potential cancers and recommends fulgurating the bases after their extirpation. This also applies to the treatment of the raw area remaining after a simple biopsy. The resulting ulcer will heal better and with less danger to the patient.

DR. M. JACKSON, (South Africa), recalled a case in which a papilloma removed from the anterior commissure proved to be malignant. Since laryngectomy was refused by the patient, Dr. Jackson removed the upper third of each vocal cord, and up to three years the patient has remained free from recurrence. He asked Dr. Le Jeune's opinion of this case.

DR. JULIUS W. MCCALL, Cleveland, stated that he has not been fortunate enough to see the patients as early as has been Dr. Le Jeune's experience. The vast majority of his patients have required laryngectomy. He would like Dr. Le Jeune to state whether the question of limitation of motility of the cord plays any part in the determination to use this procedure or to reject it.

DR. GABRIEL TUCKER, Philadelphia, like the preceding speaker, has seen extremely few patients whose cancers would be amenable to this procedure. He has had the experience of removing a small lesion for biopsy and then, at a subsequent laryngofissure, finding further evidence of carcinoma in the surrounding tissues. He feels that it is necessary to remove the internal perichondrium if

spread of the carcinoma is to be avoided, and this part of the technic can be better accomplished through a thyrotomic exposure than under suspension laryngoscopy. He has found that a good voice may result even after wide excision of the cords, through the formation of a new adventitious cord. Also, since he has been using penicillin preoperatively and postoperatively in these cases, in addition to preliminary tracheotomy, the healing has been much smoother and recovery more rapid.

Dr. John H. Foster, Houston, Texas, stated that in his part of the country (Texas and Louisiana) they do see a number of patients with laryngeal cancer in an early stage, which he believes may be attributed to publicity and the alertness of the family physicians who refer them. Also, he approves of the suspension exposure. Furthermore, the technic, like that of fenestration, requires more than average skill.

Dr. Gordon New, Rochester, Minn., in reviewing a large series of cases of carcinoma of the larynx found that 11 per cent of the patients were treated by endolaryngeal removal under suspension laryngoscopy, proving that there is a definite indication for this technic. The end results were excellent, as shown in a follow-up which revealed 92 per cent of them living and well over a five year period. The largest percentage of the tumors in this group were low grade, which is a factor that should be taken into consideration when a decision is to be made. Dr. New is enthusiastic about Dr. Le Jeune's work in this connection, following the excellent example of his predecessor Dr. Lynch.

Dr. A. H. Andrews Jr., Chicago, suggested the use of the stroboscope as an aid in obtaining early diagnosis of laryngeal carcinoma. He has found it possible to detect early infiltration of the cord by observing a rigidity either anterior or posterior to the growth, which interferes with the undulating ripple seen in the normal cord or in the presence of a small benign lesion.

Dr. Le Jeune, in closing, again emphasized the importance of a proper selection of cases. The lesion must be small and surrounded by apparently healthy tissue on all sides. Replying to Dr. Cody, Dr. Le Jeune stated that he had never used the fulgurating current in treating benign papillomas. In the case of a flat papilloma that proved malignant he would certainly perform thyrotomy rather than the procedure which he described. As for Dr. Jackson's case, he thought the technic that was carried out was correct exactly as advocated by Jackson. Concerning Dr. McCall's question relating to the limitation of motion of the cord, Dr. Le Jeune believes such a finding indicates a widespread, deep-seated lesion, which in most cases calls for laryngectomy. Relative to Dr. Tucker's discussion, it is entirely a question of whether the lesion is superficial or not. Endolaryngeal excision is indicated only for small, superficial lesions of grade 1 or grade 2 type, and when properly indicated and carried out this procedure certainly mutilates the larynx much less than thyrotomy and will result in better regeneration of the cord with better quality of voice. He has never tried the stroboscope but believes there should be some merit in its use.

Intranasal Medication—An Investigation of the Relative Merits of Methods of Introducing Fluids into the Nose. Presented by Dr. Terence Cawthorne (England).

Cawthorne conducted a series of experiments to determine the relative efficiency of the various methods of introducing medicaments into the nose. These procedures included introducing solutions by instilling nose drops, by spraying with a nasal atomizer, by sniffing and by filling the nasal chambers in the "head low" position. The criterion of efficiency was the effect on the olfactory nerves, which was determined by using a 10 per cent solution of a cocaine salt and then testing the function of this special sense. It was found that nose drops as usually employed failed to reach the deeper recesses of the nose; the nasal spray affected the olfactory area but slightly, while sniffing brought the solution into contact with a wider area

than either of the other two. Solutions introduced in the "head low" position reached the more remote recesses and induced a longer reaction because of more prolonged contact.

DISCUSSION

DR. ARTHUR W. PROETZ, St. Louis, was not surprised that the solutions introduced with the patient in the "head upside down" position reached all parts of the nose, since this had been proved previously by roentgen studies with iodized poppy-seed oil 40 per cent. However, he was surprised that the other methods employed were so relatively ineffectual. He inquired of the essayist as to toxic effects which might be expected from the introduction of a drachm (3.5 cc.) of a 10 per cent solution of a cocaine salt which was left in situ for half a minute. This is a fairly large dose, and the absorption must be rapid and considerable.

DR. CAWTHORNE, in reply to Dr. Proetz, stated that at first they did use weaker solutions but found that they could not abolish olfactory function with less than a 10 per cent solution. Although there were no marked toxic effects in any of the subjects, a definite giddy exhilarating effect was observed, which lasted for two or three hours. As far as he was able to determine there was no permanent damage.

Sensitivity from Insufflation of the Powdered Sulfonamide Compounds in Acute Infections of the Nose and Throat. Presented by DR. HOWARD BALLENGER, Winnetka, Ill.

This article will appear in full in a later issue of the ARCHIVES.

DISCUSSION

DR. RALPH A. FENTON, Portland, Ore., has observed 2 patients who reacted to powdered sulfonamide compounds used in the nose, the reaction manifesting itself in a dermatitis of the face. He asked whether Dr. Ballenger had seen anything of this nature in his series of cases.

DR. BALLENGER, in closing, stated that he accepted allergic patients if there was no history of sensitivity to sulfonamide compounds. Such patients responded to the treatment the same as nonallergic patients.

Influence of Sulfonamide Compounds and Antibiotics on the Future of Otolaryngology. Presented by DR. B. J. MCMAHON, St. Louis.

The sulfonamide drugs and the antibiotics, penicillin, tyrothricin, gramicidin and probably streptomycin, have merited by their clinical performance an important place in the treatment of infections of the upper and the lower respiratory tract.

The sulfonamide drugs and penicillin have justifiably assumed a more important role, while tyrothricin and gramicidin have a more limited use. The limitations imposed by the sensitiveness of the host and the resistance of certain microorganisms must be acknowledged.

The masking of signs and symptoms, especially in otitis media and mastoiditis, should be recognized in order to avoid fatal errors of judgment.

One should not permit optimism and wishful thinking to divert one from the main purpose of a proper and thorough training of the younger men in the basic sciences of otolaryngologic bacteriology, pathology, physiology, biochemistry, endocrinology and diagnosis, supplemented by an adequate general and special training in surgical procedures. The more highly specialized fields within the province of otolaryngology can be developed, but only as the ultimate and not as the primary objective of the well trained otolaryngologist.

DISCUSSION

DR. THOMAS C. GALLOWAY, Evanston, Ill., brought out the fact that frequently the administration of sulfonamide drugs inhibits the natural immunologic response to infection and that the inhibition frequently results in unresolved exudates that

cause permanent harm as, for instance, in the ear after otitis media. Here a plastic process may be the end result, with permanent impairment of the hearing. In connection with adenitis Dr. Galloway finds that the employment of roentgen therapy will bring about absorption and resolution, whereas the sulfonamide drugs will yield only a temporary slowing up of the process.

Dr. O. E. Van Alyea, Chicago, called attention to one of the dangers of uncontrolled sulfonamide therapy as recently brought out by some Chicago pathologists. In several cases it was shown at autopsy that widespread endarteritis nodosa was present in the brain and the heart, which could be explained on no other basis.

Dr. Frederick T. Hill, Waterville, Maine, commented on the fact that the biochemicals will not penetrate a fibrotic wall set up during an inflammatory process. He is at a loss to understand why penicillin introduced intrathecally is not recovered in the normal meninges but is found present in certain amounts when the meninges are inflamed.

Dr. William E. Grove, Milwaukee, pointed out a well known fact, that the continued administration of sulfonamide compounds frequently obscures the roentgenograms of bones, particularly the mastoid bone, so that accurate diagnosis of the progress of an infection cannot be determined from the reading of successive films.

Dr. John G. McLaurin, Dallas, Texas, reported having used penicillin solutions in the sinuses without finding the treatment of much value in clearing up the infection. It is his impression that if one is to expect results from these drugs they should be given internally or subcutaneously in large doses. If the desired results do not promptly ensue after a comparatively short period of treatment, the treatment should be discontinued.

Dr. Terence Cawthorne (England), is fairly committed to the use of antibiotics, but only if they are given in a hospital where the symptoms and reactions can be closely watched and the therapy properly controlled.

Dr. LeRoy A. Schall, Boston, viewed the problem of antibiotics in relation to otolaryngology from the point of view of medical education. More training in pathology and bacteriology is necessary, and one's conception of the indications for operation will have to be revised. He feels that instead of contracting, otolaryngology must expand so that with proper training the newer otolaryngologists will be prepared to treat allergy, cancer and neurosurgical conditions arising out of pathologic conditions of ear, nose and throat.

Dr. Fred W. Dixon, Cleveland, described 2 cases of mastoiditis apparently arrested under penicillin therapy in which recurrence of symptoms and local signs of mastoiditis led to mastoidectomy. In both cases the periosteum was found to be thickened, and the cells were filled with healthy granulations. No pus was present. He was at a loss to explain the situation but expressed the belief that the operations might have been avoided had penicillin been given a third trial.

Dr. McMahon, in closing, stated in reply to Dr. Galloway that the question of immunologic response and of the effect of antibiotics is dependent in large measure on the type and the degree of the infection. It is also possible that when there is an interval between two periods of antibiotic therapy the body defenses may have an opportunity to mobilize in response to the infection, during this interval, thus setting the stage for a more successful outcome of the second course of treatment. Concerning the use of roentgen rays in cases of infection, Dr. McMahon feels that, whether antibiotics are given or not, the procedure should be helpful because it increases the blood supply of the infected area. For this reason the application of cold to an inflamed area, the mastoid region, for instance, tends to reduce the effectiveness of the antibiotics. As for giving sulfonamide drugs to the patient at home, he makes it a practice to have the urine and the blood checked every few days so that possible ill effects may be recognized and properly treated.

Also, he is in favor of giving adequate doses from the start until the desired effect is obtained, or as long as the patient will tolerate the drug. Massive doses, however, may be dangerous, because the sudden death of large numbers of bacteria may cause fatal protein intoxication. This may explain any case of fatal meningitis in which the postmortem observations do not seem sufficient to account for death.

Concerning the masking of the roentgen evidence, as mentioned by Dr. Grove, he feels that this condition presents a challenge to one's diagnostic acumen. One's point of view on the interpretation of clinical signs must undergo revision and modification. This is corroborated by Dr. Cawthorne's statement relative to having the patient under close observation in a hospital rather than trusting to haphazard treatment in the home. Dr. McMahon agrees with Dr. Schall on the necessity of broadening one's knowledge in all related fields so that one has a thorough understanding of the patient as a whole.

He explained Dr. Dixon's cases on the redepositing of calcium in the areas where it had been previously absorbed. This would occur once the infection had been halted and was beginning to recede, and would explain changes observed in the roentgen examination.

Neurogenic Tumors of the Nose and the Throat. Presented by DR. GORDON NEW, Rochester, Minn.

This article will appear in full in a later issue of the ARCHIVES.

DISCUSSION

DR. PIERRE VIOLE, Los Angeles, recalled a case which he reported to this society two years ago, of a tumor of the carotid gland in which the patient succumbed to a postoperative hemorrhage. Subsequently he encountered a schwannoma of the throat, which was removed without any untoward effects. His thought in mentioning these cases was to emphasize the fact that preoperative diagnosis is difficult, and that one must be prepared for any contingency. Had the carotid artery been exposed under local anesthesia, ligation would have been possible in time, possibly, to save the patient's life.

DR. ROBERT C. MARTIN, San Francisco, reported having seen 2 growths similar to the first one described by Dr. New, within a period of two weeks. Both were in infants. The first proved to be a simple cystic mass. The second, which had been diagnosed at birth as meningioma, was subjected to the test described by Dr. Alfred C. Furstenberg, in which compression of the jugular veins causes an expansion of the tumor. Fortunately, this one also proved to be a dermoid cyst. It was dumbbell shaped, with one lobe presenting externally to the nasal bones and connected by a neck which passed between the nasal bones to the other lobe, which was expanded subperiosteally over the frontal bones. Its removal created a bony defect, but the inner table was not affected.

Recurring Intractable Hemorrhages of Nose. Presented by DR. SAMUEL SALINGER, Chicago.

Dr. Samuel Salinger presented a young woman who had suffered from recurring intractable hemorrhages of the nose over a period of years. The case had been reported to this association two years earlier, and to date its etiologic nature is still undetermined except for the evidence pointing to self-inflicted trauma under compulsion of a deep psychoneurotic complex, which psychoanalysis has only partially resolved. The blood picture is one of marked secondary anemia, which is being held fairly stationary by continuous medication. The nasal bones and the intranasal structures are markedly atrophied, and most of the septum is gone.

A New Anterior Commissure Laryngoscope. Presented by DR. PAUL H. HOLINGER, Chicago.

The Problem of Secondary Surgical Treatment of the Frontal Sinus. Presented by DR. F. L. WEILLE, Boston.

Dr. Weille's summary of a review of 276 cases and his conclusions follow:

The 276 patients had a total of 862 operations on the nasal cavities, the sinuses and the cranium, including plastic and encephalic procedures. Many of these operations were done outside of the Massachusetts Eye and Ear Infirmary.

Of these, 447 were performed directly on the frontal sinus or sinuses externally. Some of the patients had been referred to the infirmary as a "last resort."

Ninety-five of the patients had undergone more than one external operation on one or both frontal sinuses. The highest number on a single patient was 9.

Aside from deformity the obliterative operation is not an unmixed blessing. Thirty-three of 123 patients treated by this method required further surgical treatment of the frontal sinus region.

The repair of deformity required an average of about one year in 71 patients. The longest time was five years, three and a half months for such repair.

Only 29 of the 276 patients had no osteomyelitic *and* multiple nonobliterative operations (totaling 77) on the frontal sinus or sinuses.

A basic knowledge of applied surgical anatomy and a fundamental understanding of epithelial, connective tissue and bone responses in wound healing in the frontal region are helpful in avoiding repeated frontal operations.

Simple closure of the nasofrontal surgical opening is a paramount cause for the necessity of secondary surgical treatment of the frontal sinus. Some surgical methods of dealing with this problem are outlined.

The avoidance or simplification of surgical methods of treating frontal sinus disease may be greatly aided by chemotherapy, especially by the administration of penicillin. However, chemotherapy is not a substitute for surgical fundamentals.

Only one death occurred in the series after sulfadiazine and penicillin were used.

DISCUSSION

DR. HARRIS P. MOSHER, Marblehead, Mass., stated that at his hands surgical treatment of the frontal sinus had been disappointing. Temporary good results have been common, but recurrences have been frequent. No operation could be termed successful under four or five years. It is his belief that failure is due to inadequate care of the infected ethmoid cells in series with the frontal sinuses and to closure of the enlarged nasofrontal passage. Recurrence and reoperation in one third of the 276 cases reviewed by Dr. Weille does not speak well for the procedures employed. Secondary operation, as a rule, contemplated obliteration of the sinus, and was successful only if this objective was attained. To truly obliterate the sinus it is necessary to remove both the anterior and the posterior wall as well as the floor. This should be less objectionable than formerly, since the use of tantalum for the correction of the cosmetic deformity has been proved successful.

Unless the recently projected methods of maintaining the patency of the new nasofrontal passage, such as Goodale's suspended strip of tantalum, Weille's tantalum tube or Hoople's acrylic mold, prove definitely successful, there is no choice but a thorough obliteration of the sinus. Dr. Mosher cited Dr. Walsh's experiment in which the nasofrontal duct was left alone, as a matter well worth serious consideration. Dr. Mosher suggested further an obliterating operation in which the anterior and posterior walls are removed but the floor is left untouched. The nasofrontal duct is left alone or only lightly curetted. The ethmoid cells are exenterated through the external exposure, which permits the soft tissues to fill into the dead space. Naturally, the duct is obliterated. As mentioned before, the cosmetic defect is readily corrected by a tantalum implant.

Time alone will tell whether one's dream of the perfect frontal sinus operation, in which the duct is permanently left open, will ever be realized.

DR. W. L. SIMPSON, Memphis, Tenn., agreed that exenteration of the ethmoid cells goes a long way toward preventing recurrence of disease after an operation on the frontal sinus. In his experience it has been the median cells which caused

the most trouble and which were most often overlooked. Complete removal of all of the mucosa of the frontal sinus is extremely important, and in extensively developed sinuses this may not be thoroughly accomplished. In such cases he has found it helpful to use a small laryngeal mirror to visualize the deeper recesses. He has had no luck with dermal or mucosal grafts. As to the nasofrontal duct, Dr. Simpson has given up trying to keep it open with tubes. He leaves the duct alone and finds that he has less trouble.

Dr. Anderson Hilding, Duluth, Minn., recalled some experiments he had made in the frontal sinuses of dogs, as well as those on the turkey's trachea, in which it was shown how a diaphragm will develop in the cavity as a result of concentric contraction of the scar which forms in the denuded area. This explains some of the bad results necessitating secondary operation. He agrees with Dr. Walsh's experiment which showed how trauma of the mucosa of the duct leads to scar formation and obstruction.

Dr. George L. Tobey, Boston, brought out the point that a healed sinus may become reinfected from a new infection of the upper respiratory tract, or that it is not always a case of recurrence. Corroborating Dr. Mosher's statement about the five year period as a criterion of the permanence of the initial operation, Dr. Tobey cited 2 cases in which he had recently reoperated, in one after fifteen years and in the other after twenty years. In both cases a mucocele was found. Scar tissue had obliterated a portion of the cavity, shutting off the rest from the nasofrontal passage. He agrees with Dr. Mosher that complete obliteration is the only certain method of obtaining a permanent cure.

Dr. Jones (Washington), mentioned failures resulting from the use of vitallium tubes because of incrustation with calcium salts and referred to an article on this subject in the *Western Journal of Surgery*.

Dr. Weille, in closing, referred to Dr. Mosher's statement regarding the removal of both walls of the sinus, leaving the floor intact. The records showed 2 patients operated on in this fashion, both of whom apparently did well. Commenting on Dr. Dixon's good results, Dr. Weille mentioned the fact that in the long series of cases which he had studied there were a number in which the operation was necessitated by the presence of a serious complication, such as meningitis, thrombosis, abscess of the brain, etc. In these cases the mortality was high, and in those in which recovery occurred a secondary operation was necessary for obvious reasons. No doubt, in this class of cases better results may be expected since the advent of intensive antibiotic therapy. He cited Allman, who had a record of 52 cases of orbital abscess or local infection, in all of which the disease cleared up under chemotherapy without surgical intervention. Dr. Weille, like several of the speakers, has had no luck with skin grafts in maintaining patency of the tube. While he is impressed with Dr. Hilding's experiments and believes that the same mechanism is operative in man as in dogs, he nevertheless has found a contrary point of view in Arey's report of experimental results, published in *Physical Reviews* in 1936, which do not coincide with Hilding's results. He suggests that possibly Dr. Hilding might revise Dr. Arey's views on this point. Referring to Dr. Tobey's experience with postoperative mucoceles, the records of his series showed 48 mucoceles, of which 16 were postoperative, developing over an average of 9.2 years.

Dr. Weille has abandoned the use of vitallium tubes because of the difficulty of molding them to the proper shape.

Congenital Cysts and Fistulas About the Head and the Neck. Presented by Dr. C. D. Blassingame, Memphis, Tenn.

DISCUSSION

Dr. Gordon Berry, Worcester, Mass., raised the question whether Carnoy's solution, which is made up of ferric chloride, alcohol and chloroform, had been tried

in any of the cases. He had some good results in destroying residual fistulas with this solution in cases in which the processes were saccular rather than long tortuous passages, thus obviating the necessity of radical surgical removal with resulting scar formation.

DR. BLASSINGAME, in closing, stated that the consensus of the literature was against the use of escharotics in these cases. He feels that if the cyst or the fistula is at all accessible it should be removed in toto.

Frontal Sinus Drainage. Presented by DR. O. E. VAN ALYEA, Chicago.

Prolongation of an infection of the frontal sinus implies inadequate drainage. This may be caused by one or both of two structural defects, to wit, a blocked middle meatus or encroaching ethmoid or frontal cells. Impairment of drainage is commonly due to the presence of polyps, a cellular middle turbinate, a turbinate impinging against the lateral wall because of a septal deviation or to cells in or about the frontal sinus or its drainage pathways.

Attacks of sinusitis tend to subside quickly with removal of structural barriers. In cases in which they do not, however, cannulation is indicated.

Local manipulation is of little value and may be dangerous in the presence of acute engorgement of nasal tissues. In such cases and in those in which symptoms are severe an external opening is advisable. This is placed in the floor of the sinus at its inner angle and is made solely for the release of pus.

In chronic sinusitis, along with the correction of defects of drainage, a more extensive program may be required, including an allergy survey and a search for other contributing factors. Radical procedures which call for the removal of the mucosa of the sinus are seldom if ever indicated, and the external approach is reserved for:

1. The persistent conditions with annoying symptoms which defy all available conservative measures.

2. The release of pus under pressure in cases of severe involvement with threatening symptoms.

3. The removal of cells and growths within the sinus which are encroaching on the ostium.

4. Treatment of cancerous growths, osteomas and inflammatory conditions.

DISCUSSION

DR. BERNARD J. MCMAHON, St. Louis, agreed that certain frontal sinuses can be readily cannulated and irrigated and that such therapy materially shortens the duration of the infection. In this connection he called attention to the practice of mass suction at the anterior nares which is still practiced by some and which can only do harm by drawing the edematous mucosa into the duct, causing increased obstruction. Also, the use of diathermy may be harmful because the increased circulation produced in the tissues only adds to the engorgement already present, causing more swelling of the mucosa. Experiments on animals proved that not only does the swelling increase but capillary hemorrhages and hematoma may result. He feels that in cases of acute sinusitis every effort should be made to establish the patency of the duct by careful probing with finely wrapped applicators saturated with a shrinking solution. Also, he has found it helpful in such cases to give the patient ephedrine and pentobarbital sodium capsules, U. S. P.

Adamantinoma of the Maxillary Sinus. Presented by DR. CLYDE A. HEATLY, Rochester, N. Y.

Adamantinoma of the maxillary sinus is uncommon in the experience of most rhinologists. When the tumor is first encountered, its true nature is usually not recognized, and inadequate surgical measures are employed. The clinical picture is often mistaken for that of a malignant growth in the sinus. The adamantinoma

arises from paradental epithelial rests (Malassez), which may remain around the roots of the teeth even late in life. Irritative or traumatic factors are considered the usual causes of its growth. Two types are recognized, the solid and the cystic, the latter being far more common. Teeth may occur in these cystic tumors and suggest a mistaken diagnosis of dentigerous cyst. While pathologists usually classify the adamantinoma as a benign tumor, its relentless growth and persistent recurrence if it is incompletely removed indicate that for clinical purposes it should be regarded as a malignant growth. A true malignant variety has occurred in about 5 per cent of reported cases, and there are several accepted reports of the tumor's metastasizing to regional glands or internal organs. The adamantinoma may occur at any age but is most common in the third decade. The average duration of symptoms is around eight years. It occurs about five times more frequently in the mandible than in the maxilla. It is a slow-growing, centrally expansive tumor, the presence of which is not usually suspected clinically until expansion of the bony sinus walls has occurred. Crepitation may be demonstrated in many cases at this stage. The roentgen rays may show the diagnostic multilocular cystic structure of the tumor or simple opacity of the sinus, with thinning or erosion of its bony walls such as might be seen in a cancerous growth. Complete and radical removal of the tumor is necessary because of the certainty that recurrences will occur if small areas remain. The tendency of this tumor to proliferate in the surrounding bony cortex must be emphasized. Conservative measures, including simple curettement, will seldom prove successful. The tumor should be destroyed by electrocoagulation and the surrounding bony walls similarly coagulated or removed. The antrum should be kept accessible to subsequent examinations by maintaining the opening in the canine fossa for a long period. The rate of recurrence is exceedingly slow, and if the cavity is not open for inspection, recurrence cannot be easily detected. Postoperative irradiation is of little value, because of the radioresistant nature of the tumor, and may actually produce osteonecrosis. Periodic examination of the patients for several years is of the greatest importance because of the characteristically slow rate of recurrence. One case of the solid type of adamantinoma and one of the polycystic variety are reported.

DISCUSSION

DR. JOHN J. SHEA, Memphis, Tenn., showed some slides of an adamantinoma of the maxillary sinus, proved to be such by biopsy, in a woman who was five months pregnant. She was not seen until two years later, when the picture was apparently unchanged. She was again pregnant, and operation was again deferred.

DR. THOMAS C. GALLOWAY, Evanston, Ill., emphasized the fact that though these tumors grow slowly and seem harmless, they are insidious and extend along the periosteum to involve remote areas. His experience in 3 cases has taught him to be thorough in the surgical technic, so that no trace of the growth will be left.

Book Reviews

Principles in Roentgen Study of the Chest. By William Snow, M.D., director of radiology, Bronx Hospital; roentgenologist-in-charge, Harlem Hospital, New York. Price $10. Pp. 414. Springfield, Ill.: Charles C Thomas, Publisher, 1946.

The author presents a textbook on the principles of roentgen study of the chest and attempts to correlate the history, the physical signs and findings and the underlying physiologic and pathologic aspects of a given case. He has admirably succeeded in his purpose.

This volume totals 414 pages, and its chapters cover the following topics: "The Chest Roentgenogram," "The Average Lung," "The Role of the Bronchial Tree," "Lobar Pneumonia," "Broncho-Pneumonia," "Bronchitis," "Pleura," "Foul Lung Abscess," "Staphylococcus Sepsis," "Tuberculosis," "Neoplasms of the Chest," "Chest Injury," "The Diaphragm," "Mediastinitis," "Chronic Bulbous Emphysema," "Pneumatocele or Acquired Cystic Lung," "Pulmonary Allergy," "Post-Operative Atelectasis," "Pneumonoconiosis," "Infection with Higher Organisms," "Special Chest Problems in Children," "Circulatory System" and "The Thoracic Cage." In addition there are a bibliography and an index.

Each chapter explains the underlying physiologic and pathologic mechanisms and other details. The author is not verbose but presents his point of thought clearly and convincingly. There are in all 508 roentgenographic figures accompanying the text material, and these figures are informative and instructive. The explanations under or at the side of each roentgen study of the chest are complete, and at the end of the explanation the reader is referred to the page which discusses in greater detail the chest which is under study. The page number is printed in bold face type.

The bibliography is adequate and the index complete. This book will be of value to those otolaryngologists specializing in bronchology and thoracic surgery.

The Challenge of Polio. By Roland H. Berg. Price $2.50. Pp. 202. New York: The Dial Press, 1946.

This small compendium of the history of infantile paralysis is well done. It is worth while for physician and layman alike. Mr. Berg has a flair for the dramatic, so often lacking in medical literature.

The history of any disease necessitates careful choosing; so many men are involved, and various important personages must be dealt with gently.

The author has succeeded in conveying a fine message of the scientific and consistent research that is being fostered by the National Foundation for Infantile Paralysis. The directors seem to go to all reasonable lengths in trying out every new idea advanced by reputable people. Sister Kenny is discussed with fairness and justice.

The admixture of scientific endeavor and popular motif in the work are indeed well presented.

All in all the book is worth while reading, and especially so for intelligent laymen interested in medical things in particular and in humanity in general.

Directory of Otolaryngologic Societies *

INTERNATIONAL

First Pan-American Congress of Oto-Rhino-Laryngology and Bronchoesophagology

President: Dr. Gordon B. New, Mayo Clinic, Rochester, Minn.
Secretary: Dr. Chevalier L. Jackson, 255 S. 17th St., Philadelphia 3.

NATIONAL

American Medical Association, Scientific Assembly, Section on Laryngology, Otology and Rhinology

Chairman: Dr. J. Mackenzie Brown, 1136 W. 6th St., Los Angeles.
Secretary: Dr. Fletcher D. Woodward, 104 E. Market St., Charlottesville, Va.
Place: Atlantic City. Time: June 9-13, 1947.

American Academy of Ophthalmology and Otolaryngology

President: Dr. Alan C. Woods, Johns Hopkins Hospital, Baltimore 5.
President-Elect: Dr. C. H. McCaskey, 20 N. Meridian St., Indianapolis, Ind.
Executive Secretary-Treasurer: Dr. William L. Benedict, 100–1st Ave. Bldg., Rochester, Minn.
Place: Palmer House, Chicago. Time: Oct. 12-17, 1947.

American Broncho-Esophagological Association

President: Dr. Robert M. Lukens, Medical Arts Bldg., Philadelphia 2.
Secretary: Dr. Paul Holinger, 700 N. Michigan Ave., Chicago 11.
Place: Hotel Brighton, Atlantic City. Time: June 9, 1947.

American Laryngological Association

President: Dr. Frank R. Spencer, Physicians Bldg., Boulder, Colo.
Secretary: Dr. Arthur W. Proetz, Beaumont Bldg., St. Louis.
Place: Hotel Statler, St. Louis. Time: April 23-24, 1947.

American Laryngological, Rhinological and Otological Society, Inc.

President: Dr. Harry W. Lyman, 906 Carleton Bldg., St. Louis.
Secretary: Dr. C. Stewart Nash, 708 Medical Arts Bldg., Rochester 7, N. Y.
Place: Hotel Statler, St. Louis. Time: April 25-26, 1947.

SECTIONS:

Eastern.—Chairman: Dr. Robert F. Ridpath, 18th and Chestnut Sts., Philadelphia.
Southern.—Chairman: Dr. Walter T. Hotchkiss, 541 Lincoln Rd., Miami Beach, Fla.
Middle.—Chairman: Dr. Oliver E. Van Alyea, 135 S. La Salle St., Chicago.
Western.—Chairman: Dr. Colby Hall, 1136 W. 6th St., Los Angeles, Calif.

American Otological Society

President: Dr. William E. Grove, 324 E. Wisconsin Ave., Milwaukee, Wis.
Secretary: Dr. Gordon D. Hoople, 713 E. Genesee St., Syracuse, N. Y.
Place: Hotel Statler, St. Louis. Time: April 21-22, 1947.

American Otorhinologic Society for the Advancement of Plastic and Reconstructive Surgery, Inc.

President: Dr. Alfred Schattner, 115 E. 61st St., New York.
Secretary: Dr. Norman N. Smith, 291 Whitney Ave., New Haven, Conn.

* Secretaries of societies are requested to furnish the information necessary to keep this list up to date.